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SMITHSONIAN INSTITUTION
UNITED STATES NATIONAL MUSEUM
Bulletin 131

THE MINERALS OF IDAHO

BY

EARL V. SHANNON
Assistant Curator of Geology, United States National Museum

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NATIONAL MUSEUM

WASHINGTON
GOVERNMENT PRINTING OFFICE
1926

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The scientific publications of the National Museum include two series, known, respectively, as *Proceedings* and *Bulletin*.

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The *Bulletin*, the first of which was issued in 1875, consists of a series of separate publications comprising monographs of large zoological groups and other general systematic treatises (occasionally in several volumes), faunal works, reports of expeditions, catalogues of type-specimens, special collections, and other material of similar nature. The majority of the volumes are octavo in size, but a quarto size has been adopted in a few instances in which large plates were regarded as indispensable. In the *Bulletin* series appear volumes under the heading *Contributions from the United States National Herbarium*, in octavo form, published by the National Museum since 1902, which contain papers relating to the botanical collections of the Museum.

The present work forms No. 131 of the *Bulletin* series.

ALEXANDER WETMORE,
Assistant Secretary, Smithsonian Institution.

WASHINGTON, D. C., *February 23, 1926*,

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THE MINERALS OF IDAHO

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INTRODUCTION

The present volume contains the results of a comparatively large amount of detailed work, principally upon the specimens of Idaho ores and minerals in the United States National Museum. Together with these original observations is given a very complete compilation of such literature as pertains to the mineralogy of the State.

No such work on the minerals of a geographic area can be complete and there are doubless many occurrences of unusual minerals in the State, of which the writer has no knowledge. New discoveries will doubtless be made with increasing number from year to year and the present manuscript, however carefully compiled, can serve only as a nucleus around which to assemble new facts.

No visits to the state on observation or collecting trips have been possible since the work was begun. The writer spent many years as a collector in the Coeur d'Alene district and the statements regarding the occurrence of the minerals of that district are based upon personal observation. It has not been possible to visit this region within the past several years or at any time since training was acquired in the recognition of obscure or unusual minerals.

The specimens preserved in the National Museum have, for the most part, been random selections of typical ores or specimens selected to illustrate some geologic phenomenon without particular reference to the mineralogy and such unusual minerals as they contain are nearly wholly accidental. In cases where mineral occurrences have not been mentioned, the excuse must be that no specimen was available for examination.

Many remarkably fine specimens have been lost through smelting or otherwise and the occurrence of many minerals in abundance in rich ores is now established only by fragmentary records substantiated by a single specimen accidentally preserved. It is hoped that one purpose of this publication will be accomplished by arousing interest of persons possessing a latent interest in mineralogy in the preservation of unusual mineral specimens. It has not been possible, during the preparation of this report, to establish connections with a single resident mineralogist or mineral collector in the State nor to locate a mining man or prospector having an active interest in mineralogy.[1]

The National Museum is in a position at all times to carefully identify any mineral which may be sent in for examination free of charge and any specimen of merit which may be donated is assured of careful and permanent preservation in the Museum collections. It is to be hoped that in the not distant future there may be established, as a part of the excellent educational system of the State of Idaho, a State museum devoted to the adequate care and preservation of the minerals and other natural history material of the area.

Many mineralogic problems which have developed during the course of the work have had to be left more or less in the air because of inadequate material, but each investigation has been pursued as far as the specimens at hand permitted.

The general properties, beyond the mere statement of the composition and crystallization of the minerals, could not be given, and for these reference must be had to a standard textbook. For the more common minerals Ford's revision of Dana's Textbook of Mineralogy is recommended, while for details regarding the rarer species the standard reference work, Dana's System of Mineralogy, must be consulted.

It has not been possible to revise the arrangement of the text, which is alphabetical, by counties, in accord with the recent subdivision and creation of new counties, and the locality references are, with a few exceptions, based upon the county map of 1914. The districts mentioned are essentially as defined in Hill's Mining Districts of the Western United States, United States Geological Survey Bulletin 507. The Idaho section of this valuable work is reprinted below, with some additions to the bibliography.

GEOLOGIC SUMMARY OF THE OCCURRENCE OF METALLIFEROUS ORES IN IDAHO.[2]

Ore deposits are irregularly distributed in Idaho. The extreme southern and eastern parts of the State are almost barren. The mining districts are most abundantly clustered in a region extending from the vicinity of Boise in a northeasterly direction to Lemhi County and the Salmon River Valley. The most important output is that of lead and silver from the Coeur d'Alene district, in the northern part of the State. Gold and silver are derived from the belt mentioned and from veins in Owyhee County, in the southwest corner of the State.

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[1] Since the above was written a number of men, including Dean Francis A. Thomson, of the Idaho State School of Mines, and Stewart Campbell, State mine inspector of Idaho, have assisted by sending unusual minerals from the State to the United States National Museum for identification.

[2] By Waldemar Lindgren. Reprinted without change from U. S. Geol. Survey Bulletin 507, pp. 24–26, 1912.

The most prominent geologic feature is the great central mountain mass bordering Montana and continued on the north by the Clearwater and Coeur d'Alene Mountains. The eastern part of this mountain mass consists of pre-Cambrian and Paleozoic strata, the extreme western part of Triassic sediments. Between these two lies a great intrusive mass of granitic rocks, principally quartz monzonite, continued on the north and east by smaller intrusive areas. The northern or panhandle part of the State is mainly built up of the steeply inclined sedimentary strata of a thick pre-Cambrian complex known as the Belt series. The southern and southwestern parts of the State are covered by thick volcanic flows of Tertiary age, and this area connects on the east with the lavas of the Yellowstone Park region and Utah. Toward the Nevada line rise a number of short ranges of the type of the Basin Ranges of that State, and the extreme southeastern part of Idaho is occupied by north-south ranges built up of folded and faulted Paleozoic and Mesozoic rocks which may be considered as a northward extension of the Wasatch Mountain system.

Pre-Cambrian deposits are not present in Idaho, except possibly in some of the less important districts in the northern part of the State, where mineralization seems to have accompanied intrusion of diabase sills in the Belt series. Here as elsewhere two important kinds of deposits may be recognized—those which were formed shortly after the intrusion of the great central batholith of Jurassic rocks, probably in late Cretaceous time, and those of late Tertiary age which developed after the outburst of the Tertiary lavas in the southern and central parts of the State. The latter are confined to the gold and silver veins of Owyhee County and to a belt of lavas in the central part of the State, including such deposits as the Custer, in Custer County; the Singiser veins in Lemhi County; and the Thunder Mountain deposits in Idaho County.

A few unimportant deposits of copper and lead ores of uncertain age occur in the Paleozoic limestones of the ranges in the extreme southeast corner of the State.

The upper parts of the late Cretaceous ore deposits have to a considerable extent been removed by erosion and the parts now exposed contain ores formed at considerable depths. They are mainly fissure veins, but in places, as in southern Lemhi County and at the Wood River (Hailey) district, these merge into replacement deposits of galena in limestone. Contact-metamorphic deposits containing copper ores are developed on a rather extensive scale at Seven Devils, near the Oregon boundary line, and at White Knob, in the southeastern part of Custer County, but neither place has proved a large or steady producer.

The veins are contained in a great number of districts situated in and around the borders of the central granitic mass. Most of them carry gold and silver in a quartz gangue with abundant sulphides. Among the best known districts are those of the Idaho Basin and the vicinity of Boise, adjoined on the east by the Sawtooth, Atlanta, and Rocky Bar districts. To the northeast are a number of minor districts in Lemhi County. To the north are those of Warren, Florence, Buffalo Hump, Dixie, Elk City, and Pierce. Still farther north, surrounding a smaller granitic intrusive mass, cluster the lead-silver bearing veins of the Coeur d'Alene district. The late Cretaceous gold-bearing veins have usually yielded placer deposits of importance, many of which are still producing. The placer districts of greatest present importance are in the Idaho Basin, along the eastern boundary of Lemhi County, and at Pierce. The now largely exhausted placers of Warren, Florence, Elk City, and the Coeur d'Alene region should also be mentioned. The fine gold occurring in the sands of Snake River has been described frequently, but the actual production from these deposits is very small. Placers of diminishing importance are situated along Salmon and Boise Rivers.

Among the Tertiary veins those near Silver City and De Lamar, in Owyhee County, have been and are still important producers. These veins cut through early Tertiary rhyolites and basalt and bear clear evidence of having been formed within short distances of the present surface.

Less well known are the veins at Custer, and also those of a few districts like Singiser, in Lemhi County, which occur under similar conditions. Low-grade gold ores have been mined at Thunder Mountain, in Idaho County, and are said to form disseminations in rhyolitic tuffs. The Tertiary veins carry gold and silver with a very small amount of sulphides and no important amount of base metals.

Idaho contains few deposits of iron, and none of them is mined at present. Iron Mountain, in Washington County, near Snake River, is the principal locality. No rare-metal deposits of importance occur in Idaho.

METAL PRODUCTION OF IDAHO

It is deemed appropriate to here give a few figures on the amount and value of the metal production of the State in order to convey some idea of the importance of the mining industry which, after all, is concerned entirely with obtaining and marketing minerals. The following figures are taken from State Mine Inspector Robert N. Bell's annual report for 1918.

Estimated total value of metals mined previous to 1898, $381,315,312.

1898

Gold, fine ounces, 91,698	$1, 895, 566. 00
Silver, fine ounces, 5,256,700	3, 654, 020. 00
Lead, pounds, 122,479,275	4, 899, 171. 00
Total value	10, 448, 757. 00

1899

Gold, fine ounces, 75,054	1, 550, 958. 00
Silver, fine ounces, 4,480,174	2, 688, 105. 00
Lead, pounds, 86,499,506	3, 760, 553. 00
Copper, pounds	60, 000. 00
Total value	6, 059, 606. 00

1900

By direct shipment:	
Gold, fine ounces, 102,782	2, 124, 603. 94
Silver, fine ounces, 4,324,133	2, 534, 480. 00
Lead, pounds, 96,425,500	3, 857, 020. 00
Copper	35, 000. 00
Total value	8, 551, 103. 94
Through the United States assay office	1, 699, 760. 22
Estimated from other sources	1, 000, 000. 00
Total value	11, 250, 864. 16

1901

Gold, fine ounces, 110,228	2, 280, 422. 76
Silver, fine ounces, 3,305,154	1, 983, 092. 00
Lead, pounds, 65,967,000	2, 638, 680. 00
Total value	6, 902, 194. 76

1902

Gold, fine ounces, 119,363	2, 567, 233. 21
Silver, fine ounces, 5,259,778	3, 655, 866. 00
Lead, pounds, 119,223,000	4, 172, 805. 00
Total value	10, 295, 905. 01

1903

Gold, fine ounces, 92,938.42	2, 085, 993. 76
Silver, fine ounces, 7,224,021.58	4, 338, 312. 60
Lead, pounds, 220,857,956	9, 386, 213. 13
Copper, pounds, 2,524,000	336, 954. 00
Total value	16, 143, 573. 49

1904

Gold, fine ounces, 84,461.89	1, 845, 282. 08
Silver, fine ounces, 8,284,639.12	4, 970, 783. 40
Lead, pounds, 226,261,728	9, 729, 425. 86
Copper, pounds, 5,422,007.05	704, 860. 91
Total value	17, 250, 898. 25

1905

Gold, fine ounces, 60,515.91	$1, 250, 863. 85
Silver, fine ounces, 8,626,794.55	5, 196, 270. 51
Lead, pounds, 269,791,456	12, 257, 198. 43
Copper, pounds, 6,661,400	1, 025, 189. 46
Zinc, pounds, 2,174,960	127, 887. 89
Total value	19, 876, 409. 89

1906

Gold, fine ounces, 58,762.32	1, 214, 617. 15
Silver, fine ounces, 9,136,860.73	6, 071, 443. 96
Lead, pounds, 255,966,083	14, 487, 680. 30
Copper, pounds, 11,640,565	2, 252, 449. 32
Zinc, pounds, 1,447,000	91, 426. 30
Antimony, pounds, 90,000	20, 700. 00
Total value	24, 138, 317. 03

1907

Gold, fine ounces, 66,426.29	1, 373, 031. 40
Silver, fine ounces, 8,491,366.13	5, 546, 553. 82
Lead, pounds, 234,404,920	12, 470, 341. 74
Copper, pounds, 10,487,905	2, 241, 177. 17
Zinc, pounds, 9,192,551	534, 087. 21
Total value	22, 165, 191. 34

1908

Gold, fine ounces, 68,145.16	1, 409, 992. 97
Silver, fine ounces, 7,660,507.38	4, 407, 811. 63
Lead, pounds 207,998,499	8, 764, 485. 35
Copper, pounds, 10,110,506	1, 336, 608. 89
Zinc, pounds, 64,000	3, 020. 80
Total value	15, 561, 131. 64

1909

Gold, fine ounces, 70,898,938	1, 465, 487. 05
Silver, fine ounces, 7,039,451.20	3, 625, 317. 40
Lead, pounds, 217,594,679	9, 356, 571. 20
Copper, pounds, 7,759,886	1, 034. 651. 50
Zinc, pounds, 1,906,200	104, 841. 00
Total value	15, 606, 862. 00

1910

Gold, fine ounces, 49,289.22	1, 018, 808. 26
Silver, fine ounces, 7,890,388	4, 268, 813. 00
Lead, pounds, 239,144,570	10, 761, 057. 70
Copper, pounds, 5,837,639	753, 055. 40
Zinc, pounds, 5,995,600	33, 513. 60
Total value	17, 135, 695. 90

1911

Gold, fine ounces, 66,927.11	$1, 375, 068. 22
Silver, fine ounces, 8,592,400	4, 579, 621. 15
Lead, pounds, 274,492,873	12, 225, 912. 56
Copper, pounds, 3,962,060	502, 488. 67
Zinc, pounds, 10,087,600	386, 593. 94
Total value	19, 270, 212. 00

1912

Gold, fine ounces, 69,300.10	1, 432, 434. 00
Silver, fine ounces, 8,238,971	5, 011, 766. 00
Lead, pounds, 296,054,813	13, 233, 650. 00
Copper, pounds, 7,392,280	1, 224, 161. 00
Zinc, pounds, 16,243,840	1, 127, 316. 00
Total value	22, 029, 327. 00

1913

Gold, fine ounces, 67,792	1, 450, 531. 50
Silver, fine ounces, 10,163,205	6, 044, 925. 11
Lead, pounds, 318,377,280	13, 907, 447. 04
Copper, pounds, 8,627,242	1, 316, 509. 20
Zinc, pounds, 30,271,323	1, 707, 352. 62
Total value	24, 572, 396. 47

1914

Gold, fine ounces, 62,238	1, 286, 459. 46
Silver, fine ounces, 13,621,123	7, 412, 378. 77
Lead, pounds, 345,334,106	13, 426, 086. 23
Zinc, pounds, 49,239,000	2, 166, 351. 90
Copper, pounds, 5,178,000	685, 430. 00
Total value	24, 976, 706. 36

1915

Gold, fine ounces, 60,746	1, 255, 619. 00
Silver, fine ounces, 12,933,619	6, 426, 715. 00
Lead, pounds, 369,242,000	17, 243, 601. 00
Zinc, pounds, 93,410,000	12, 993, 331. 00
Copper, pounds, 7,365,000	1, 288, 685. 00
Antimony, pounds, 70,950	28, 380. 00
Tungsten ore, pounds 54,000	81, 000. 00
Total value	39, 315, 312. 00

1916

Gold, fine ounces, 53,079	1, 061, 580. 00
Silver, fine ounces, 12,205,132	8, 013, 889. 00
Lead, pounds, 366,594,000	25, 111, 689. 00
Zinc, pounds, 98,700,740	12, 633, 694. 00
Copper pounds, 8,052,725	2, 190, 341. 00
Tungsten, pounds, 120,000	91, 500. 00
Total value	49, 102, 693. 00

1917

Gold, fine ounces, 41,326	$826, 520. 00
Silver, fine ounces, 12,496,017	10, 173, 000. 00
Lead, pounds, 395,883,000	34, 758, 506. 00
Zinc, pounds, 96,123,000	8, 555, 947. 00
Copper, pounds, 7,282,000	1, 979, 247. 00
Total value	56, 292, 210. 00

1918

Gold, fine ounces, 36,307.83	750, 482. 83
Silver, fine ounces, 9,572,214	8, 709, 988. 63
Lead, pounds, 290,848,425	22, 368, 310. 50
Zinc, pounds, 51,691,000	4, 212, 816. 50
Copper, pounds, 5,240,400	1, 278, 483. 78
Total value	37, 320. 082. 43
Total value of all metals for 21 years since State records were kept	465, 513, 764. 43
Total value of all metals for preceding 38 years (estimated)	381, 315, 312. 00
Grand total from discovery to end of 1918	846, 829, 076. 43

METAL PRODUCTION FOR 1918 BY COUNTIES

The following table gives some idea of the relative importance of the several counties of the State in their contributions to the total value of the metal production:

Ada County

Gold, fine ounces, 343.74	$7, 105. 10
Silver, fine ounces, 406.65	393. 51
Total value	7, 498. 61

Adams County

Gold, fine ounces, 28.45	588. 06
Silver, fine ounces, 770	745. 13
Copper, pounds, 30,000	7, 386. 00
Total value	8, 719. 19

Blaine County

Gold, fine ounces, 898.40	18, 569. 92
Silver, fine ounces, 261,000	252, 569. 70
Lead, pounds, 2,725,000	201, 922. 50
Zinc, pounds, 2,035,000	165, 852. 50
Total value	638, 914. 62

Boise County

Gold, fine ounces, 10,810	223, 442. 70
Silver, fine ounces, 24,682	23, 884. 77
Total value	247, 327. 47

Bonneville County

Gold, fine ounces, 157	$3, 245. 19
Silver, fine ounces, 19	18. 38
Total value	3, 263. 57

Bonner County

Gold, fine ounces, 70	1, 446. 90
Silver, fine ounces, 2,004	1, 939. 27
Lead, pounds, 190,000	14, 079. 00
Total value	17, 465. 17

Boundary County

Gold, fine ounces, 60	1, 240. 20
Silver, fine ounces, 129,644	125, 456. 50
Lead, pounds, 7,494,000	555, 305. 40
Total value	682, 002. 10

Butte County

Gold, fine ounces, 49	1, 012. 83
Silver, fine ounces, 6,600	6, 386. 82
Lead, pounds, 436,000	32, 307. 60
Total value	39, 707. 25

Clearwater County

Gold, fine ounces, 217.24	4, 490. 35
Silver, fine ounces, 4,400	4, 257. 88
Total value	8, 748. 23

Camas County

Gold, fine ounces, 245	5, 064. 15
Silver, fine ounces, 70	67. 73
Total value	5, 131. 88

Custer County

Gold, fine ounces, 2,758	57, 007. 86
Silver, fine ounces, 153,000	148, 058. 10
Copper, pounds, 3,500,000	861, 700. 00
Lead, pounds, 2,200,000	163, 020. 00
Total value	1, 229, 785. 96

Elmore County

Gold, fine ounces, 270	5, 580. 90
Silver, fine ounces, 87	84. 19
Total value	5, 665. 09

Fremont County

Gold, fine ounces, 50	1, 033. 50
Silver, fine ounces, 500	483. 85
Copper, pounds, 100,000	24, 620. 00
Total value	26, 137. 35

Idaho County

Gold, fine ounces, 3,587	$74, 143. 29
Silver, fine ounces, 1,700	1, 645. 09
Total value	75, 788. 38

Latah County

Gold, fine ounces, 30	620. 10
Silver, fine ounces, 170	164. 50
Copper, pounds, 85,000	20, 927. 00
Total value	21, 711. 60

Lemhi County

Gold, fine ounces, 1,189	24, 576. 63
Silver, fine ounces, 143,000	138, 381. 10
Copper, pounds, 68,000	5, 038. 90
Lead, pounds, 4,744,000	1, 167, 972. 80
Total value	1, 335, 969. 33

Owyhee County

Gold, fine ounces, 900	18, 603. 00
Silver, fine ounces, 34,000	32, 901. 80
Total value	51, 504. 80

Shoshone County

Gold, fine ounces, 14,628	302, 360. 76
Silver, fine ounces, 8,234,389	7, 968, 418. 23
Lead, pounds, 273,059,425	20, 233, 703. 39
Zinc, pounds, 49,656,000	4, 046, 964. 00
Copper, pounds, 1,449,000	356, 743. 80
Total value	32, 908, 190. 18

Washington County

Gold, fine ounces, 17	531. 39
Silver, fine ounces, 4,270	4, 132. 08
Copper, pounds, 8,400	2, 068. 08
Total value	6, 551. 55

Totals for State for Year 1918

Gold, fine ounces, 36,307.83	750, 482. 83
Silver, fine ounces, 9,572,214	8, 709, 988. 63
Lead, pounds, 290,848,425	22, 368, 310. 69
Zinc, pounds, 51,691,000	4, 212, 816. 50
Copper, pounds, 5,240,400	1, 278, 483. 78
Total value for 1918	37, 320, 082. 43
Total value for 1917	56, 292, 210. 00
Decrease	18, 972, 127. 57

IDAHO MINING DISTRICTS

The following section has in large part been taken from Hill's Mining Districts of the Western United States (James M. Hill, United States Geological Survey Bulletin 507, 1912), from which the Idaho portion has been reprinted without change except for additions to the bibliography. Such additions have been of titles of papers which have come under the present writers notice which are believed to have some interest, either mineralogically or as related to the metalliferous mines. By no means all of the geologic literature relating to the State is mentioned.

As previously mentioned this classification of the districts has been followed in the body of this manuscript and it has not been possible to revise the text to conform with recent creation of new counties, since it is often difficult to determine, without tedious research and correspondence, just where a given mine or district lies with reference to the changed geographic boundaries.

For references to papers on Idaho geology not mentioned here the reader is referred to John M. Nichols' bibliographies published as bulletins of the United States Geological Survey, particularly to Bulletins 746 and 747, which are complete for the period from 1785 to 1918, and to subsequent bulletins by the same author. Bulletin of the United States Bureau of Mines, No. 166, A Preliminary Report on the Mining Districts of Idaho, Washington, 1919, should also be consulted. Many references not found in this section will be found in footnotes in the body of the present work. References to published descriptions, in the following tabulation of mining districts are, unless otherwise stated, to publications of the United States Geological Survey. The abbreviations used in stating these are as follows:

M.	Monograph.
P. P.	Professional Paper.
Bull.	Bulletin.
W. S. P.	Water Supply Paper.
Min. Res.	Mineral Resources.
Folio	Folio of Geologic Atlas of the United States.
Top. sheet	Topographic map sheet of the topographic Atlas of the United States.

The data given for the Black Hornet district may be taken and explained to give a key to the meaning of the abbreviations, etc., used for the other districts.

ADA COUNTY

1. Black Hornet (Highland Valley, Shaw Mtn.) Au, Ag (D., Pl.).
 8 miles east of Boise, O. S. L. R. R.
 Granite cut by granite-porphyry.
 Veins.
 Lindgren, W., The mining districts of Idaho Basin and Boise Ridge, Idaho. 18th Ann. Rept., pt. 3, 1898, pp. 703, 705, 707.
 Min. Res. 1905, pp. 224–225.
 1906, pp. 249–250.
 1907, pp. 288–289, pt. 1.
 1908, pp. 414, pt. 1.
 1909, pp. 431, pt. 1.
 Top sheet Boise.
 Folio 45, 1898.

In the first line are given the three names by which the district is known. The abbreviations Au and Ag are chemical symbols indicating that gold and silver are the metals mined in the district, gold, mentioned first, being the more important. The abbreviations D and Pl. in parenthesis indicate that both deep mines and placers are worked, the deep mines, mentioned first, being the most important. The second line gives the location of the district with reference to the nearest railroad point—8 miles east of Boise station on the Oregon Short Line Railroad. The next line states that the inclosing rocks are granite cut by granite porphyry and the fourth line that the deposits of the deep mines are veins. The references are to the third part of the Annual Report of the United States Geological Survey for 1898 and to several volumes of the series of reports of the United States Geological Survey on the Mineral Resources of the United States. Finally the last two lines indicate that the district is within the area covered by the topographic map of the Boise quadrangle and by geologic folio No. 45, both published by the United States Geological Survey.

The abbreviations used for the metals mined are as follows:

Au	Gold.	Ti	Titanium.	Bi	Bismuth.
Ag	Silver.	Mn	Manganese.	U	Uranium.
Cu	Copper	Ni	Nickel.	V	Vanadium.
Pb	Lead.	Co	Cobalt.	Sn	Tin.
Zn	Zinc.	W	Tungsten.	Mo	Molybdenum.
Hg	Mercury.	Sb	Antimony.	Pt	Platinum.
Fe	Iron.	As	Arsenic.	Pd	Palladium.
Cr	Chromium.				

IDAHO

ADA COUNTY

1. Black Hornet (Highland Valley, Shaw Mountain). Au, Ag (D, Pl.), 8 miles east of Boise, O. S. L. R. R.
 Granite cut by granite porphyry.
 Veins.

Lindgren, W., The mining districts of Idaho Basin and Boise Ridge, Idaho. 18th Ann. Rept., pt. 3, 1898, pp. 703, 705, 707.
Min. Res. 1905, pp. 224–225.
1906, pp. 249–250.
1907, pp. 288–289, pt. 1.
1908, pt. 1, p. 414.
1909, pt. 1, p. 341.
Top. sheet Boise.
Folio, 45, 1898.

2. Boise (McIntyre). Au, Ag, 3 to 5 miles east of Boise, O. S. L. R. R.
Granite cut by granite porphyry and lamprophyre dikes.
Veins.
Lindgren, W., The mining districts of Idaho Basin and Boise Ridge, Idaho. 18th Ann. Rept., pt. 3, 1898, p. 705.
Min. Res. 1907, pt. 1, p. 288.
1908, pt. 1, p. 414.
1909, pt. 1, p. 341.

3. Snake River placers. Au (Pl.).
Stream gravels.
Min. Res. 1905, p. 224.
1907, pt. 1, p. 289.
Top. sheet Bisuka.
Hill, J. M., Notes on the fine gold of Snake River, Idaho. U. S. Geol. Surv., Bull. 620, pp. 271–294, 1915.
Bell, R. N., The origin of the fine gold of Snake River. Eng. Mining Journ., vol. 73, pp. 143–144, 1902.
Irvine, C. D., Fine gold of Snake River, Idaho. Mining World, vol. 29, p. 917, 1908.
Maguire, Don., Snake River gold fields of Idaho. Mines and Minerals, vol. 20, pp. 56–58, 1899.
Washburn, W. H., Gold in Snake River bars. Mining Scientific Press, vol. 81, pp. 610, 1900.
Cross, C. Whitman, Gold sand from Snake River, Idaho, Colo. Sci. Soc., Proc., vol. 1, pp. 36–37, 1885.
The above references apply generally to Snake River placer sand.

ADAMS COUNTY. (See Washington.)

BANNOCK COUNTY

4. Fort Hall. Cu, Ag, Au, Pb., 9 miles east of Pocatello, 1½ miles west of Portneuf, O. S. L. R. R.
Paleozoic sediments and diabase.
Veins.
Weed, W. H., Copper mines in the United States in 1905. Bull. 285, 1906, pp. 107–108.
Weeks, F. B., and Heikes, V. C., Notes on the Fort Hall mining district, Idaho. Bull. 340, 1908, pp. 175–183.
Min. Res. 1905, p. 225.
1906, p. 250.
1907, pt. 1, p. 289.
1908, pt. 1, p. 414.
1909, pt. 1, p. 341.

Breger, C. L., The salt resources of the Idaho-Wyoming border, with notes on the geology. U. S. Geol. Surv., Bull. 430, pp. 555–569, 1910

Richards, R. W., and Bridges, J. H., Sulphur deposits near Soda Springs, Idaho. U. S. Geol. Survey, Bull. 470, pp. 499–503, 1911.

BEAR LAKE COUNTY

5. Bear Lake. Cu., 4 miles east of Montpelier, O. S. L. R. R.

Triassic "Red Beds."

Disseminations.

Gale, H. S., Geology of the copper deposits near Montpelier, Idaho. Bull. 430, 1910, pp. 112–121.

Weeks, F. B., and Ferrier, W. F., Phosphate deposits in the western United States. Bull. 315, 1907, pp. 460–461.

Weeks, F. B., Phosphate deposits in the western United States. Bull. 340, 1908, pp. 441–444.

Min. Res. 1905, p. 225.
1906, p. 250.
1907, pt. 1, pp. 289–290.

(Phosphate and Coal) Schultz, A. R., A geologic reconnaissance for phosphate and coal in southeastern Idaho, etc. U. S. Geol. Survey, Bull. 680, 1918.

6. St. Charles. Pb, Ag, Cu. 5 miles south of Paris, O. S. L. R. R.

Paleozoic sediments.

Veins and replacements.

Richards, R. W., Notes on lead and copper deposits in the Bear River Range, Idaho and Utah. Bull. 470, 1911, pp. 177–187.

BINGHAM COUNTY

Mansfield, G. R. and Larsen, E. S. Nepheline basalt in the Fort Hall Indian Reservation, Idaho. Journ. Wash. Acad. Sci., vol. 5, pp. 463–468, 1915.

BINGHAM AND BONNEVILLE COUNTIES

7. Mount Pisgah (Caribou). Cu, Au, Ag. (Pl, D.). 42 miles NNE. Soda Springs, O. S. L. R. R.

Min. Res. 1905, p. 225.
1906, p. 250.
1907, pt. 1, p. 290.
1908, pt. 1, p. 415.
1909, pt. 1, p. 342.

8. Snake River placers. Au (Pl.).

Steam gravels.

Min. Res. 1905, p. 225.
1906, p. 250.
1907, pt. 1, p. 290.
1908, pt. 1, p. 415.
1909, pt. 1, p. 342.

BLAINE COUNTY

Lakes, Arthur, The Dollarhide Mine [Wood River region] Idaho. Mining World, vol. 24, p. 437, 1906.

Umpleby, J. B., Ore deposits in the Sawtooth quadrangle, Blaine and Custer Counties, Idaho. U. S. Geol. Surv., Bull. 580, pp. 221–249, 1914.

Blake, W. P., Wood River, Idaho, Silver-lead mines. Eng. Mining Journ., vol. 4, pp. 2–3, 1887.

Lakes, Arthur, Some of the veins of ore deposits of the Wood River district, Idaho. Mining World, vol. 23, pp. 696–697, 1905.

——— The Wood River mining district of Idaho. Mining World, vol. 34, pp. 307–308, 1911.

Shannon, Earl V., Boulangerite, bismutoplagionite, nammaunite, and a silver-bearing variety of jamesonite. Proc. U. S. Nat. Mus., vol. 58, pp. 589–607, 1920.

——— Additional notes on the crystallography and composition of boulangerite. Amer. Journ. Sci., vol. 1, pp. 423–426, 1921.

9. Antelope. Ag, Pb.
    17 miles SW. Darlington, O. S. L. R. R.
    Min. Res. 1908, pt. 1, p. 416.
    Prof. Paper 97, p. 119, pp. 113–114.

10. Camas. Au.
    20 miles SW. Hailey, O. S. L. R. R.
    Granite and diorite.
    Veins.
    Lindgren, W., The gold and silver veins of Silver City, De Lamar, and other mining districts in Idaho. Twentieth Ann. Rept., pt. 3, 1900, p. 208.

11. Dome. Pb, Ag, Cu, Au.
    28 miles NE. Arco, O. S. L. R. R.
    Paleozoic sediments and granite.
    Veins and replacements.
    Eldridge, G. H., A geological reconnaissance across Idaho. Sixteenth Ann. Rept., pt. 2, 1895, pp. 264–271.
    Min. Res. 1906, p. 251.
    1907, pt. 1, p. 291.
    1908, pt. 1, p. 416.
    1909, pt. 1, pp. 342–343.
    Umpleby, P. P., U. S. Geol. Surv., No. 97, pp. 113–115.
    U. S. Bureau of Mines, Bull. 166, p. 68.

12. Elkhorn (Ketchum). Pb, Ag.
    Station O. S. L. R. R.
    Paleozoic sediments.
    Veins.
    Lindgren, W., The gold and silver veins of Silver City, De Lamar, and other mining districts in Idaho. Twentieth Ann. Rept., pt. 3, 1900, pp. 209–211.
    Min. Res. 1882, pp. 311–312.
    1883, 1884, pp. 424–425.
    1885, p. 258.
    Top. sheet Hailey.
    Jenney, W. P., Graphitic anthracite in the Parker Mine, Wood River, Idaho. Sch. of Mines Quarterly, vol. 10, pp. 313–315, 1889.

Era District
    P. P. 97, pp. 120–122.

13. Galena. Pb, Ag.
    26 miles NW. Ketchum, O. S. L. R. R.
    Min. Res. 1882, pp. 311–312.
    1883–84, pp. 424–425.
    1885, p. 258.
    1886, p. 146.
    Top. sheet Sawtooth.
14. Hamilton (Clyde). Cu, Pb, Ag, Au.
    28 miles NE. Mackay, O. S. L. R. R.
    Paleozoic sediments.
    Veins.
    Min. Res. 1907, pt. 1, p. 291.
    1908, pt. 1, p. 416.
    Umpleby, P. P. 97, p. 113.
15. Lava Creek (Martin). Ag, Cu, Pb.
    24 miles SW. Arco, O. S. L. R. R.
    Paleozoic sediments, granite.
    Veins and replacements.
    Eldridge, G. H., A geological reconnaissance across Idaho. Sixteenth Ann. Rept., pt. 2, 1895, pp. 264–271.
    Min. Res. 1906, p. 251.
    1907, pt. 1, p. 291.
    1908, pt. 1, p. 416.
    Umpleby, P. P. 97, pp. 122–123.
16. Little Smoky. Au, Pb, Ag.
    28 miles west of Hailey, O. S. L. R. R.
    Paleozoic sediments cut by granite.
    Veins and replacements.
    Lindgren, W., The gold and silver veins of Silver City, De Lamar, and other mining districts in Idaho. Twentieth Ann. Rept., pt. 3, 1900, p. 209.
    Min. Res. 1908, pt. 1, p. 416.
    1909, pt. 1, p. 343.
    Top. sheet Sawtooth.
17. Little Wood River (Muldoon). Pb, Ag.
    20 miles east of Bellevue, O. S. L. R. R.
    Paleozoic sediments.
    Veins and replacements.
    Min. Res. 1882, pp. 311–312.
    1883–84, pp. 424–425.
    1885, p. 258.
    1908, pt. 1, p. 416.
    1909, pt. 1, p. 343.
    Finch, Elmer H. Muldoon district, Idaho. U. S. Geol. Surv., 1917, Prof. paper 97, pp. 106–109.
18. Mineral Hill (Hailey). Pb, Ag, Zn, Cu, Au.
    Station O. S. L. R. R.
    Paleozoic sediments cut by granitic rocks.
    Veins.
    Lindgren, W., The gold and silver veins of Silver City, De Lamar, and other mining districts in Idaho. Twentieth Ann. Rept., pt. 3, 1900, pp. 190–209.

Min. Res. 1882, pp. 311–312.
1883–84, pp. 424–425.
1887, p. 107.
1905, pp. 226–227.
1906, pp. 251–252.
1907, pt. 1, pp. 291–292.
1908, pt. 1, pp. 416–417.
1909, pt. 1, p. 343.
Top. sheet Hailey.

19. Rosetta. Au, Ag, Pb, Zn.
30 miles west of Ketchum, O. S. L. R. R.
Paleozoic sediments cut by granitic rocks
Veins.
Min. Res. 1905, p. 227.
1906, p. 252.
1907, pt. 1, p. 292.
1909, pt. 1, p. 335.
Top. sheet Sawtooth.

20. Sawtooth. Ag.
40 miles NW. Ketchum, O. S. L. R. R
Granite.
Veins.
Min. Res. 1885, p. 258.
Top. sheet Sawtooth.

21. Snake River placer (Neeley). Au (Pl).
Neeley Station, O. S. L. R. R.
Stream gravels.
Min. Res. 1905, p. 227.
1906, p. 252.
Hill, J. M., Notes on the fine gold of Snake River, Idaho, U. S. Geol. Surv. Bull. 62, p. 292, etc., 1915.

22. Soldier. Au (Pl).
33 miles north of Gooding, O. S. L. R. R.
Stream gravels.
Min. Res. 1908, pt. 1, p. 417.
1909, pt. 1, p. 343.

23. Warm Springs. Ag, Pb, Zn, Au.
12 miles west of Ketchum, O. S. L. R. R.
Min. Res. 1882, pp. 311–312.
1883–84, pp. 424–425.
1905, p. 227.
1906, p. 253.
1907, pt. 1, p. 292.
1908, pt. 1, p. 417.
1909, pt. 1, p. 343.
Top sheet Sawtooth.

BOISE COUNTY

Jones, E. L., jr., Lode mining in the Quartzburg and Grimes Pass belt, Boise Basin, Idaho. U. S. Geol. Surv., Bull. 640, pp. 83–111, 1916.

Lindgren, W., Monazite from Idaho. Amer. Journ. Sci., vol. 4, pp. 63–64, 1897. Mining Scientific Press, vol. 75, pp. 168, 1897.

Shannon, Earl V., On galenobismutite from a gold quartz vein in Boise County, Idaho. Wash. Acad. Sci., Journ., vol. 11 pp. 298–300, 1921.

——— Notes on Anglesite, anthophyllite, calcite datolite, sillimanite, stilpnomelane, tetrahedrite and triplite. Proc. U. S. Nat. Mus., vol. 58, pp. 437–453, 1920.

——— Mineralogy of some black sands from Idaho with a description of the methods used for their study. Proc. U. S. Nat. Mus., vol. 60, art. 3, 33 pp., 1921.

——— Notes on the mineralogy of three gouge clays from precious metal veins. Proc. U. S. Nat. Mus., vol. 62, art. 9, 1922.

24. Banner. Ag.
76 miles NE. Boise, O. S. L. R. R.
Granite.
Veins.
Top. sheet Bear Valley.
(Coal). Bowen, C. F., Coal at Horseshoe Bend and Jerusalem Valley, Boise County, Idaho, U. S. Geol. Surv., Bull. 531, pp. 245–251, 1913.

25. Moore Creek. Au, monazite (Pl.). .
Stream gravels.
Top. sheet Idaho Basin.

26. Centerville (Idaho Basin). Au (D, Pl.).
44 miles NE. Boise, O. S. L. R. R.
Granite cut by aplite and lamprophyres.
Veins, stream gravels.
Lindgren, W., The mining districts of Idaho Basin and Boise Ridge, Idaho. Eighteenth Ann. Rept., pt. 3, 1898, pp. 617–744.
Min. Res. 1905, pp. 228–229.
1906, p. 253–254.
1907, pt. 1, p. 293.
1908, pt. 1, pp. 418–419.
1909, pt. 1, p. 344.
Top. sheet Idaho Basin.
Hastings, John B., The Boise Basin in Idaho. Eng. Mining Journ., vol. 58, p. 560, 1894, Scientific Amer. Supplement, vol. 38, pp. 15540–15541, 1894.
Nye, Robert, The Boise Basin mining district. Mining and Scientific Press, vol. 81, p. 400, 1900.

27. Deadwood. Au (Pl.).
80 miles NE. Boise, O. S. L. R. R.
Stream gravels.
Min. Res. 1907, pt. 1, p. 293.
1908, pt. 1, p. 419.
1909, pt. 1, p. 345.
Hill, W. H., The Deadwood placer claims, Idaho. Eng. Mining Journal, vol. 60, pp. 225–226, 1895.
Top. sheet Bear Valley.

28. Gold Fork (Roseberry). Au (Pl.).
41 miles SE. Evergreen, P. & I. N. R. R.
Tertiary gravels.
Lindgren, W., The gold and silver veins of Silver City, De Lamar, and other mining districts in Idaho. 20th Ann. Rept., pt. 3, 1900, p. 242.

29. Highland Valley. Au (D, Pl.).
    18 miles ESE. Boise, O. S. L. R. R.
    Granite cut by granite porphyry.
    Veins.
    Min. Res. 1908, pt. 1, p. 414.
    1909, pt. 1, p. 345.
    Top. sheet Boise.
    Folio 45, 1898.

30. Idaho City (Idaho Basin). Au, monazite (D, Pl.).
    36 miles NE. Boise, O. S. L. R. R.
    Granite cut by aplite and lamprophyres.
    Veins, stream gravels.
    Lindgren, W., The mining districts of Idaho Basin and Boise Ridge, Idaho. Eighteenth Ann. Rept., pt. 3, 1898, pp. 617–744.
    Min. Res. 1905, pp. 228–229.
    1906, pp. 253–254.
    1907, pt. 1, p. 293.
    1909, pt. 1, p. 344.
    Top. sheet Idaho Basin.

Moore Creek. (See No. 25.)

31. Payette River placers (Jacobs Gulch). Au (Pl.).
    Stream gravels.
    Min. Res. 1908, pt. 1, p. 419.
    1909, pt. 1, p. 345.
    Top. sheets Garden Valley, Squaw Creek.

32. Quartzburg (Idaho Basin). Au, monazite (D, Pl.).
    51 miles NNE. Boise, O. S. L. R. R.
    Granite cut by diorite porphyry.
    Veins, stream gravels.
    Lindgren, W., The Mining districts of Idaho Basin and Boise Ridge, Idaho. 18th Ann. Rept., pt. 3, 1898, pp. 617–744.
    Min. Res. 1905, pp. 228–229.
    1906, pp. 253–254.
    1907, pt. 1, p. 293.
    1908, pt. 1, pp. 418–419.
    1909, pt. 1, p. 344.
    Top. sheet Idaho Basin.

33. Summit Flat (Pioneerville). Au, Ag.
    50 miles NNE. Boise, O. S. L. R. R.
    Granite cut by aplite and lamprophyre.
    Veins.
    Lindgren, W., The mining districts of Idaho Basin and Boise Ridge, Idaho. 18th Ann. Rept., pt. 3, 1898, pp. 617–744, p. 695.
    Min. Res. 1907, pt. 1, p. 294.
    1908, pt. 1, p. 420.
    1909, pt. 1, p. 345.
    Top. sheets Idaho Basin, Garden Valley.

34. Twin Springs. Au (Pl).
    41 miles East of Boise, S. L. R. R.
    Stream gravels.
    Top. sheet Twin Springs.

35. Westview (Willow Creek, Pearl, Rock Creek). Au, Ag, Pb.
    8 miles NE. Emmett, P. & I. N. R. R., 15 miles north of Eagle, O. S. L. R.R.
    Granite cut by granite and diorite porphyry dikes.
    Veins.
    Lindgren, W., The mining districts of Idaho Basin and Boise Ridge, Idaho. 18th Ann. Rept., pt. 3, 1898, p. 707.
    Min. Res. 1905, p. 229.
    1906, p. 255.
    1907, pt. 1, p. 294.
    1908, pt. 1, p. 420.
    1909, pt. 1, p. 345.
    Top. sheet Boise.
    Folio 45, 1898.

Bonner County

(Includes Boundary County)

Curtis, W. M., The Priest Lake mining district, Idaho. Engineering & Mining Jour., vol. 82, p. 866, 1906.

Soper, E. K., The mining districts of northern Idaho. Mining & Sci. Press, vol. 116, pp. 121–127, 1918.

Lancaster, Joseph, The Priest Lake district, Idaho. Mining World, vol. 32, p. 100, 1910.

Daly, Reginald A., Geology of the North American Cordillera at the Forty-ninth Parallel. Canada Dept. Interior, Report of Chief Astronomer for 1910, vols. 2 and 3, pp. 1–799, map, 1913. Also issued as Memoir 38 of Canada Geol. Survey, Ottawa, 1915.

Daly, Reginald A., The differentiation of a secondary magma through gravitative adjustment. (Moyie sill in the Purcell Mountain Range, Idaho-Montana). Festschrift Harry Rosenbusch, pp. 203–233, Stuttgart, 1906.

36. East Shore (Clark Fork). Cu, Au, Ag, Pb.
    Clark Fork and Hope stations, N. P. R. R.
    Algonkian sediments (Belt Series).
    Veins.
    Calkins, F. C., and MacDonald, D. F., A geological reconnaissance in northern Idaho and northwestern Montana. Bull. 384, 1909, pp. 95–97.
    MacDonald, D. F., Economic features of northern Idaho and northwestern Montana. Bull. 285, 1906, pp. 47–48.
    Min. Res. 1907, pt. 1, p. 294.
    1908, pt. 1, p. 420.
    1909, pt. 1, p. 345.
    U. S. Bureau of Mines Bull. 166, pp. 14 and 16–17, 1919.

37. Kootenai. Ag. Pb.
    40 miles NW. of Iola, G. N. R. R.

38. Mooyie Yaak. Au, Pb, Ag. (Now Boundary County.)
    19 miles NE. Bonners Ferry, G. N. R. R.
    Calkins, F. C., and MacDonald, D. F., A geological reconnaissance in northern Idaho and Northwestern Montana. Bull. 384, 1909, pp. 107–108.
    U. S. Bureau of Mines Bull. 166, p. 14, 1919.

39. Pend Orielle (Blacktail). Au, Ag, Cu, Pb.
    5 miles east of Westbound, N. P. R. R.
    Pre Cambrian (Belt?) sediments cut by monzonites.
    Veins.

Calkins, F. C., and MacDonald, D. F., A geological reconnaissance in northern Idaho and Northwestern Montana. Bull, 384, pp. 97–99, 1909.
MacDonald, D. F., Economic features of western Idaho and Northwestern Montana. Bull. 285, 1906, pp. 46–47.
Min. Res. 1907, pt. 1, p. 294.
1908, pt. 1, pp. 240, 421.
1909, pt. 1, p. 345.
Top. sheet Sandpoint.
U. S. Bureau of Mines Bull. 166, pp. 15–16, 1909.

40. Pine Creek. Au, Ag, Pb, Zn.
12 miles NNW. Priest River, G. N. R. R.
Veins.
MacDonald, D. F., Economic features of northern Idaho and northwestern Montana. Bull. 285, 1906, pp. 45–46.
Top. sheet, Sandpoint.

41. Priest Lake (Coolin). Pb, Ag, Cu. Au. (Now Boundary County.)
25 miles north of Priest River, G. N. R. R.
Pre Cambrian sediments, granite.
Veins.
Min. Res. 1908, pt. 1, p. 420.
1909, pt. 1, p. 345.
U. S. Bureau of Mines, Bull. 166, pp. 13–14, 1919.
Top. sheet, Sandpoint.

BONNEVILLE COUNTY

(See Bingham County)

CASSIA COUNTY

Black Pine (Quicksilver). See E. S. Larsen, University of Idaho School of Mines Bull. 2, pp. 65–67, 1920.

42. Connor Creek (Cumora, Stokes). Au, Ag, Pb, Cu.
38 miles SSE. Burley, O. S. L. R. R.
Veins.
Min. Res. 1905, pp. 229–230.
1906, p. 255.
1907, pt. 1, p. 295.
1908, pt. 1, p. 421.

Goose Creek (Coal). See C. F. Bowen, Lignite in the Goose Creek district, Cassia County, Idaho. U. S. Geol. Survey Bull. 531, pp. 252–262, 1913.

43. Snake River Placers. Au. (Pl.)
Stream gravels.
Min. Res. 1905, pp. 229–230.
1906, p. 255.
1907, pt. 1, p. 295.

CLEARWATER COUNTY

(Formerly part of Nez Perce County)

Shannon, Earl V., Description of vivianite incrusting a fossil tusk from gold placers of Clearwater County, Idaho. U. S. National Museum, Proceedings vol. 59, pp. 415–417, 1921.

103. Burnt Creek. Au (Pl.), 35 miles NE. Ahsahka, N. P. R. R.
Stream gravels.
Min. Res. 1905, p. 237.
1906, p. 261.
1907, pt. 1, p. 304.
1908, pt. 1, p. 429.
1909, pt. 1, p. 351.

104. Moose City. Au (Pl.), 80 miles NE. Ahsahka, N. P. R. R.
Stream gravels.

105. Musselshell Creek (Weippe). Au, monazite (D, Pl.), 25 miles East of Greer, N. P. R. R.
Granite, gneiss, and schist.
Veins, stream gravels.
Lindgren, W., A geological reconnaissance across the Bitterroot Range and Clearwater Mountains. P. P. 27, 1904, p. 105.
Schrader, F. C., An occurrence of monazite in northern Idaho. Bull. 430, 1910, pp. 184–190.

Orofino (coal). See Chas. T. Lupton. The Orofino coal field, Clearwater, Lewis and Idaho Counties, Idaho. U. S. Geol. Survey Bull. 621, pp. 99–108, 1915.

106. Pierce. Au (D, Pl.), 28 miles NE. Greer, N. P. R. R.
Granite, gneiss, and schist.
Veins, bench gravels.
Lindgren, W., Mineral deposits of the Bitterroot Range and Clearwater Mountains. Bull 213, 1903, pp. 66–70.
——— A geological reconnaissance across the Bitterroot range and Clearwater Mountains. P. P. 27, 1904, pp. 102–105.
Russell, I. C., Geology and water resources of Nez Perce County, Idaho, pt. 2. W. S. P. 54, 1901.
Min. Res. 1905, p. 237.
1906, pp. 261–262.
1907, pt. 1, p. 304.
1908, pt. 1, p. 429.
1909, pt. 1, p. 351.

CUSTER COUNTY

Jennings, E. P., The Lost Packer copper gold mine. Canada Mining Institute Journal, vol. 9, pp. 54–57, 1906 and Mining & Scientific Press, vol. 92, pp. 435–436, 1906.

Kemp, J. F., and Gunther, C. G., The White Knob copper deposits at Mackay, Idaho. American Inst. Mining Engrs. Bulletin, vol. 14, pp. 301–328, (1907) and Transactions, vol. 38, pp. 269–296, 1908.

Bell, Robert N., An outline of Idaho geology and of the principal ore deposits of Lemhi and Custer Counties. Fourth International Mining Congress, Proceedings, pp. 64–80, 1901.

——— The Ramshorn mine at Bayhorse, Idaho. Mines and Minerals, vol. 21, pp. 174–176, 1900.

Ross, Clarence S., and Shannon, Earl V., Mordenite and associated minerals from near Challis, Custer Co., Idaho. U. S. National Museum, Proceedings vol. 64, art. 19, 1924.

Shannon, Earl V., An iron amphibole similar to hudsonite from Custer County, Idaho. Amer. Journ. Sci., vol. 8, pp. 323–324, 1924.

Koch, Louis A., A new occurrence of ptilolite. Amer. Mineralogist, vol. 2, pp. 143–144, 1917.

Julien, Alexis A., The volcanic tuffs of Challis, Idaho. (Abstract). New York Academy of Sciences, Trans. vol. 1, pp. 49–56, 1882, Science, vol. 2, pp. 606–609, 1881.

44. Alder Creek (Lost River, White Knob). Cu, Au, Ag, Pb. Mackay Station, O. S. L. R. R.

Paleozoic sediments, granite and porphyry.

Contact metamorphic.

Weed, W. H., the copper mines of the United States in 1905, Bull. 285, 1906, p. 108.

Umpleby, J. B., Geology and ore deposits of the Mackay region, Idaho. Prof. Paper 97, 1917.

——— The genesis of the Mackay copper deposits, Idaho. Economic Geology, vol. 9, pp. 307–358, 593–594, 1914.

——— Crystallized chrysocolla from Mackay, Ida. Wash. Acad. Sci. Journ., vol. 4, pp. 181–183, 1914.

——— Schaller, W. T., and Larsen, E. S., Custerite, a new contact metamorphic mineral. Amer. Journ. Sci., vol. 36, pp. 385–394, 1913.

Min. Res. 1905, p. 230.
1906, p. 255.
1907, pt. 1, p. 295.
1908, pt. 1, p. 422.
1909, pt. 1, p. 346.

45. Bay Horse. Ag, Pb, Cu, Au., 76 miles NW. of Mackay, O. S. L. R. R.

Paleozoic sediments cut by granite.

Veins and replacements.

Min. Res. 1887, p. 107.
1905, p. 230.
1906, p. 256.
1908, pt. 1, p. 422.
1909, pt. 1, p. 346.

Umpleby, J. B., Ore deposits of northwestern Custer County, Idaho. Bull. 539, pp. 59–76, 1913.

Bell, Robert N., The Ramshorn mine at Bayhorse. Mines and Minerals, vol. 21, pp. 174–176, 1900.

46. East Fork. Pb, Ag, 24 miles west of Mackay, O. S. L. R. R.

Min. Res. 1908, pt. 1, p. 422.

Umpleby, J. B., P. P. 97, pp. 103–106, 1917.

47. Loon Creek (Casto, Lost Packer). Au, Ag, Cu. 125 miles NW. Mackay, O. S. L. R. R.

Precambrian sediments cut by granite and capped by rhyolite.

Veins.

Umpleby, J. B., A preliminary account of the ore deposits of the Loon Creek district, Idaho. Bull. 530, 1912.

Weed, W. H., The copper mines of the United States in 1905. Bull. 285, 1906, p. 108.

Umpleby, J. B., Some ore deposits of NW. Custer Co., Idaho. Bull. 539, p. 94, 1913.

Min. Res. 1906, p. 256.
1907, pt. 1, p. 295.
1908, pt. 1, p. 422.
1909, pt. 1, p. 346.

48. Seafoam. Au, Ag, 109 miles NW. Ketchum, O. S. L. R. R.
Min. Res. 1905, p. 230.
1908, pt. 1, p. 422.
1909, pt. 1, p. 346.
Ida. Bur. Geology & Mines, Bull. 3, 1920.
Top. sheet, Bear Valley.

49. Sheep Mountian. Ag, Pb.
131 miles NW. Ketchum, O. S. L. R. R.
Granite and schist cut by diorite and quartz porphyry.
Replacements.
Eldridge, G. H., A geological reconnaissance across Idaho. Sixteenth Ann. Rept., pt. 2, 1895, p. 258.
Idaho Bureau Mines & Geology, Bull. 3, pp. 13–17, 1920.
Top. sheet Bear Valley.

50. Stanley Basin. Au, Ag (D. Pl.).
89 miles NW. of Ketchum, O. S. L. R. R.
Granite and porphyry.
Veins, stream gravels.
Min. Res. 1905, p. 230.
1906, p. 256.
1907, pt. 1, p. 296.
1908, pt. 1, p. 422.
1909, pt. 1, p. 346.
Idaho Bureau of Geology and Mines, Bull. 3, pp. 13–17, 1920.
Hess, F. L., and Wells, R. C., Brannerite, a new mineral. Journal Franklin Institute, vol. 189, pp. 225–237, 1920.
Top. sheet Bear Valley.

51. Washington Basin. Au, Ag.
48 miles NW. of Ketchum, O. S. L. R. R.
Umpleby, J. B., Ore deposits in the Sawtooth quadrangle, Blaine and Custer Counties, Idaho. Bull. 580, pp. 244–246, 1915.

52. Yankee Fork (Custer). Au, Ag.
114 miles NW. of Mackay, O. S. L. R. R.
Tertiary volcanics.
Veins.
Min. Res. 1905, p. 231.
1906, p. 256.
1907, pt. 1, p. 296.
1908, pt. 1, pp. 421–422.
1909, pt. 1, p. 346.
Umpleby, J. B., Some ore deposits in Northwestern Custer County, Idaho. Bull. 539, pp. 80–89, 1913.

Elmore County

53. Atlanta. Au, Ag (D. Pl.).
89 miles NE. Mountain Home, O. S. L. R. R.
Granite cut by quartz porphyry.
Veins, stream gravels.
Eldridge, G. H., A geological reconnaissance across Idaho. Sixteenth Ann. Rept., pt. 2, 1895, pp. 253–257.
Min. Res. 1905, p. 231.
1906, p. 257.
1907, pt. 1, p. 297.

53. Atlanta—Continued

Min. Res. 1908, pt. 1, pp. 423–424.
1909, pt. 1, p. 347.

Thomson, James. The geology of the territory of Idaho, U. S., and the silver lode of Atlanta (Abstract). Geol. Society of Glasgow, Scotland, Transactions, vol. 8, pp. 173–177, 1886.

Clayton, Joshua E., Atlanta district. Amer. Inst. Mining Engineers, Transactions, vol. 5, pp. 468–473, 1877, and Engineering and Mining Journal, vol. 23, pp. 374–375, 1877.

Hastings, John B., The Atlanta Lode, Idaho. Engineering and Mining Journal, vol. 59, p. 28, 1895.

Bell, Robert N., Atlanta gold district, Idaho. Engineering and Mining Journal, vol. 86, pp. 176–177, 1908.

——— Rich gold ore found in Idaho. Engineering and Mining Journal, vol. 102, pp. 783–785, 1916.

Top. sheet Rocky Bar.

54. Black Warrior. Au, Ag.

99 miles NE. Mountain Home, O. S. L.
Granite cut by quartz porphyry.
Veins.
Min. Res. 1906, p. 256.
1907, pt. 1, p. 297.
1908, pt. 1, p. 423.
1909, pt. 1, p. 347.
Top. sheet Rocky Bar.

55. Highland Valley. Au, Ag (Pl.).

25 miles ESE. Boise, O. S. L. R. R.
Stream gravels.
Min. Res. 1907, pt. 1, p. 297.
1908, pt. 1, p. 423.
1909, pt. 1, p. 347.
Top. sheet Idaho Basin.

56. Neal. Au, Ag.

25 miles SE. Boise, O. S. L. R. R.
Granite cut by granite- and syenite-porphyry and lamprophyre.
Veins.
Lindgren, W., The mining districts of Idaho Basin and Boise Ridge, Idaho. Eighteenth Ann. Rept., pt. 3, 1898, pp. 699–703.
Min. Res. 1905, p. 225.
1906, p. 250.
1907, pt. 1, p. 297.
1908, pt. 1, p. 424.
1909, pt. 1, p. 347.
Top. sheet Idaho Basin.

57. Pine Grove. Au, Ag.

45 miles NE. Mountain Home, O. S. L. R. R.
Veins (?).
Min. Res. 1905, p. 231.
1906, p. 257.
1907, pt. 1, pp. 297–298.
1908, pt. 1, p. 424.
1909, pt. 1, p. 347.
Top. sheet Camas Prairie.

58. Rocky Bar (Bear Creek). Au, Ag.
  65 miles NE. Mountain Home, O. S. L. R. R.
  Granite cut by diorite, diabase, and quartz porphyry.
  Veins.
  Eldridge, G. R., A geological reconnaissance across Idaho. Sixteenth Ann. Rept., pt. 2, 1895, pp. 250–253.
  Min. Res. 1907, pt. 1, p. 297.
  1908, pt. 1, p. 423.
  1909, pt. 1, p. 347.
  Top. sheet Rocky Bar.

Fremont County

Horseshoe Creek (coal). See Woodruff, E. G., The Horseshoe Creek district of the Teton Basin coal field, Fremont County, Idaho. U. S. Geol. Survey Bull. 541, pp. 379–388, 1914.

59. Little Lost River (How). Pb, Ag.
  25 miles NE. of Arco, O. S. L. R. R.
  Min. Res. 1908, pt. 1, p. 424.
  1909, pt. 1, p. 347.

60. Skull Canyon (Kaufman). Cu, Pb, Ag, Au.
  50 miles West of Dubois, O. S. L. R. R.
  Paleozoic sediments.
  Replacements.
  Weed, W. H., The copper mines of the United States in 1905: Bull. 285, 1906, p. 108.
  Umpleby, J. B., Prof. Paper 97, pp. 110–112, 1917.
  Min. Res. 1905, p. 231.
  1906, p. 257.
  1907, pt. 1, p. 298.
  1908, pt. 1, p. 424.

Idaho County

Jellum, S. P., Central Idaho gold districts (including Lolo, Pardee, Pierce, Newsome, Elk City, Orogrande-Fourmile, Buffalo Hump, Dixie, etc.). Northwest Mining News, vol. 3, pp. 83–91, 107–114, 134–139; vol. 4, pp. 2–6, 31–37, 66–73, (1908–9). Reprinted, 84 pp., Spokane, Wash., 1909.

Maguire, Don, Central Idaho gold field. Mines and Minerals, vol. 19, pp. 289–291, 1899.

Schrader, F. C., An occurrence of monazite in Northern Idaho. U. S. Geol. Survey, Bull. 430, pp. 184–190, 1910.

Silliman, Benjaman, jr., On an association of gold with scheelite in Idaho. Amer. Journ. Sci., vol. 13, pp. 451–452, 1877.

Thomson, Francis A., Gold veins of sundry areas in the Idaho batholith. Eng. and Mining Journ., vol. 118, No. 14, pp. 533–540, 1924.

61. Big Creek. Au, Ag, Pb, Cu.
  60 miles west of Kooskia, N. P. R. R.
  Veins.
  Min. Res. 1907, pt. 1, p. 299.
  1908, pt. 1, p. 425.
  1909, pt. 1, p. 348.
  Livingston, D. C., and Umpleby, J. B., A reconnaissance in south central Idaho. Ida. Bureau Mines and Geology, Bull. 3, pp. 7–12, 1920.

62. Camp Howard (White Bird). Cu, Au, Ag.
    12 miles SSW. Grangeville, N. P. R. R.
    Paleozoic sediments cut by diorite.
    Veins.
    Lindgren, W., A geological reconnaissance across the Bitterroot Range and Clearwater Mountains in Montana and Idaho. P. P. 27, 1904, p. 107.
    Min. Res. 1907, pt. 1, p. 299.
    1908, pt. 1, p. 425.

63. Cottonwood Buttes. Au, Ag, Cu.
    Cottonwood station, N. P. R. R.
    Pretertiary sediments.
    Veins.
    Lindgren, W. P. P. 27, 1904, pp. 106–107.

64. Crooks Corral. Au, Ag (Pl.).
    51 miles north of Evergreen, P. & I. N. R. R.
    Bench gravels.
    Min. Res. 1907, pt. 1, p. 299.
    1908, pt. 1, p. 425.

65. Dewey (Harpster). Au, Cu.
    7 miles west of Grangeville, N. P. R. R.
    Slates and schist cut by diorite.
    Veins.
    Lindgren, W., P. P. 27, 1904, pp. 105–106.

66. Dixie. Au, Ag.
    78 miles southeast of Grangeville, N. P. R. R.
    Granite.
    Veins.
    Lindgren, W., Mineral deposits of the Bitterroot Range and Clearwater Mountains, Montana. Bull. 213, 1903, pp. 66–70.
    ——— A geological reconnaissance across the Bitterroot Range and Clearwater Mountains in Idaho and Montana. P. P. 27, 1904, pp. 91–96.
    Min. Res. 1905, p. 232.
    1906, p. 258.
    1907, pt. 1, p. 299.
    1908, pt. 1, p. 425.
    1909, pt. 1, p. 348.
    U. S. Bureau of Mines Bull. 166, p. 41, 1919.
    Livingston, D. C., and Stewart, C. A., The geology and ore deposits of the Dixie district, Idaho. Idaho University Bulletin 9, No. 2, 1914.

67. Elk City. Au, Ag (D. Pl.).
    52 miles SE. of Grangeville, N. P. R. R.
    Pre-Cambrian gneiss cut by granite.
    Veins, stream gravels.
    Lindgren, W., Mineral deposits of the Bitterroot Range and Clearwater Mountains, Montana. Bull. 213, pp. 66–70.
    ——— A geological reconnaissance across the Bitterroot Range and Clearwater Mountains, in Montana and Idaho. P. P. 27, 1904, pp. 91–96.
    Min. Res. 1905, p. 232.
    1906, p. 258.
    1907, pt. 1, p. 299.
    1908, pt. 1, p. 425.
    1909, pt. 1, p. 348.

67. Elk City—Continued.
    Flagg, Arthur L., The Elk City mining district, Idaho. Amer. Inst. Mining Eng., Bull., vol. 76, pp. 571–580; Trans., vol. 45, pp. 113–122, map, 1914.

68. Florence. Au (D, Pl.).
    42 miles SSE. of Grangeville, N. P. R. R.
    Granite.
    Veins, stream gravels.
    Lindgren, W., Mineral deposits of the Bitterroot Range and Clearwater Mountains, Montana and Idaho. Bull. 213, pp. 66–70, 1903.
    ——— The gold and silver veins of Silver City, De Lamar and other Mining districts of Idaho. Twentieth Ann. Rept., pt. 3, 1900, pp. 232–237.
    Min. Res. 1905, p. 232.
    1906, p. 258.
    1907, pt. 1, p. 299.
    1909, pt. 1, p. 348.

69. Maggie. Au (Pl.).
    8 miles east of Kooskia, N. P. R. R.
    Stream gravels.
    Min. Res. 1906, p. 258.

70. Marshall (Resort). Au. Ag (D. Pl.).
    50 miles NE. of Evergreen, P. & I. N. R. R.
    Granite.
    Viens, stream gravels.
    Lindgren, W., The gold and silver veins of Silver City, De Lamar, and other mining districts in Idaho. Twentieth Ann. Rept., pt. 3, 1900, p. 277.
    Min. Res. 1905. p. 252.
    1907, pt. 1, p. 300.
    1908, pt. 1, p. 425.
    1909, pt. 1, p. 348.

71. Newsome. Au (D. Pl.).
    31 miles east of Grangeville, N. P. R. R.
    Pre-Cambrian gneiss, cut by granite.
    Veins, terrace gravels.
    Lindgren, W., Mineral deposits of the Bitterroot Range and Clearwater Mountains, Montana. Bull. 213, 1903, pp. 66–70.
    Min. Res. 1905, p. 233.
    1906. p. 258.
    1907, pt. 1, p. 300.
    1908, pt. 1, p. 425.
    1909, pt. 1, p. 348.

72. Orogrande. Au, Ag (D. Pl.).
    61 miles SE. of Grangeville, N. P. R. R.
    Pre-Cambrian gneiss cut by granite.
    Veins, stream gravels.
    Lindgren, W., A geological reconnaissance across the Bitterroot Range and Clearwater Mountains in Montana and Idaho. P. P. 27, 1904, pp. 94–98.
    Min. Res. 1905, p. 233.
    1906, pp. 425–426.
    1909, pt. 1, p. 349.

73. Profile. Au.
151 miles NE. of Emmett, P. & I. N. R. R.
Tertiary volcanics.
Veins and impregnations.

74. Robbins (Buffalo Hump). Au, Ag.
50 miles SE. of Grangeville, N. P. R. R.
Granite schist cut by granite dikes.
Veins.
Lindgren, W., Mineral deposits of the Bitterroot Range and Clearwater Mountains, Montana. Bull. 213, 1903, pp. 66–70.
——— A geological reconnaissance across the Bitterroot Range and Clearwater Mountains in Idaho and Montana. P.P. 27, 1904, pp. 99–102.
Min. Res. 1995, p. 233.
1906, pp. 258–259.
1907, pt. 1, p. 300.
1908, pt. 1, p. 426.
1909, pt. 1, p. 349.
Flagg, Arthur L., Buffalo Hump mining district, Idaho. Mining World, vol. 38, pp. 813–814, 1913.
Whittle, C. L., The Buffalo Hump mining camp, Idaho. Eng. and Mining Journ., vol. 68, pp. 215–216, 1899.

75. Salmon River placers (Simpson). Au, Ag (Pl.).
Stream gravels.
Min. Res. 1905, pp. 233–234.
1906, p. 259.
1907, pt. 1, p. 300.
1908, pt. 1, p. 426.
1909, pt. 1, p. 349.

76. Thunder Mountain. Au, Ag.
139 miles NE. Emmett, P. & I. N. R. R.
Tertiary volcanics.
Veins and impregnations.
Min. Res. 1905, p. 234.
1906, p. 259.
1907, pt. 1, p. 300.
1908, pt. 1, p. 426.
1909, pt. 1, p. 349.

L'Hame, Wm. E., Thunder Mountain, Idaho. Mines and Minerals, vol. 21, p. 558, 1901.

——— Thunder Mountain district, Idaho. Mines and Minerals, vol. 24, pp. 207–209, 1903.

Umpleby, J. B., and Livingston, D. C., A reconnaissance in south central Idaho. Idaho Bureau Mines and Geology, Bull. 3, pp. 3–6, 1920.

77. Warren. Au, Ag, Cu (D. Pl.).
67 miles NE. of Evergreen, P. & I. N. R. R.
Granite cut by lamprophyre dikes.
Veins.
Lindgren, W., The gold and silver veins of Silver City, De Lamar, and other mining districts in Idaho. Twentieth Ann. Rept. pt. 3, 1900, pp. 237–249.
Min. Res. 1905, p. 234.
1906, p. 259.
1907, pt. 1, pp. 300–301.

77. Warren—Continued.
    Min. Res. 1908, pt. 1, p. 426.
        1909, pt. 1, p. 349.
    Hill, W. H., The Little Giant mine at Warren, Idaho. Eng. and Mining Journ., vol. 62, p. 417, 1896.

KOOTENAI COUNTY

78. Camas Cove (Tyson). Au (Pl.).
    18 miles SSE. of St. Maries, C. M. & St. P. R. R.
    Stream gravels.
    Min. Res. 1905, p. 234.
        1907, pt. 1, p. 301.
        1908, pt. 1, p. 426.
    U. S. Bureau of mines, Bull. 166, pp. 17–18.

79. Lakeview. Ag, Pb.
    15 miles east of Athol, N. P. R. R.
    Pre-Cambrian sediments.
    Veins.
    Calkins, F. C., and MacDonald, D. F., A geological reconnaissance in western Idaho and northwestern Montana. Bull. 384, 1909, pp. 42, 60, 62, 95–96.
    Min. Res. 1905, p. 234.
        1906, p. 259.
    U. S. Bureau of mines, Bull. 166, pp. 14–15, 1919.
    Top. sheet, Rathdrum.

80. Medimont. Ag.
    Cataldo and Dudley stations, O. W. R. & N. R. R.
    Algonkian sediments.
    Veins.
    Min. Res. 1905, p. 234.

LATAH COUNTY

Kunz, George F., On the occurrence of opal in northern Nevada and Idaho. Annals New York Acad. Sci., vol. 21, pp. 214–215, 1912.

Sterrett, D. B., Mica in Idaho and New Mexico and Colorado. U. S. Geol. Survey Bull. 530, pp. 375–390, 1913.

Shannon, Earl V., Note on a garnet from a pegmatite in Idaho. Amer. Mineralogist, vol. 7, pp. 171–173, 1922.

81. Gold Creek (Potlatch). Au (Pl.).
    Station, W. I. & M. R. R.
    Stream gravels.
    Min. Res. 1905, p. 234.
        1907, pt. 1, p. 301.
        1908, pt. 1, p. 426.
    U. S. Bureau of mines, Bull. 166, p. 34, 1919.

82. Hoodoo (Blackbird). Au, Cu (D. Pl.).
    8 to 12 miles NNE. of Harvard, W. I. & M. R. R.
    Min. Res. 1905, p. 234.
        1907, pt. 1, p. 301.
        1908, pt. 1, p. 426.
    Livingston, D. C. and Laney, F. B., Idaho Bureau of Geology and Mines, Bull. 1, pp. 92–97, 1920.

83. Moscow. Au (Pl. D.).
    Station, N. P. R. R.
    Stream gravels.
    Min. Res. 1905, p. 234.
    1906, p. 259.
    1907, pt. 1, p. 301.
    Top. sheet, Pullman.

LEMHI COUNTY

Hidden, Wm. Earl., The Hayden Creek, Idaho, meteorite. Amer. Journ. Sci., vol. 9, pp. 367–368, 1900.

Ross, Clyde P., A new copper district near Salmon, Idaho. Eng. and Mining Jour., vol. 118, pp. 205–208, 1924.

84. Blackbird. Cu, Au, Ag, Ni, Co.
    25 miles west of Noble, C. & P. R. R.
    Pre-Cambrian schist cut by basic dikes and granite.
    Veins and replacements.
    Umpleby, J. B., Ore deposits of Lemhi County, Idaho. Bull. 528, pp. 159–165, 1913.

85. Bluewing (Patterson Creek). Ag, W.
    80 miles north of Mackay, O. S. L. R. R.
    Granite.
    Veins.
    Umpleby, J. B., Bull. 528, pp. 109–112, 1913.

86. Carmen Creek, Au, Cu.
    Station G. & P. R. R.
    Pre-Cambrian schists.
    Veins.
    Min. Res. 1907, pt. 1, p. 320.
    Umpleby, J. B., Bull. 528, pp. 126–127, 1913.

87. Eldorado (Geertson). Au.
    10 miles NE. of Baker, G. & P. R. R.
    Pre-Cambrian schists cut by basic dikes.
    Veins.
    Min. Res. 1905, p. 236.
    1908, pt. 1, p. 427.
    1909, pt. 1, p. 350.
    Umpleby, J. B., Bull. 528, pp. 123–124, 1913.

88. Eureka. Au, Ag.
    8 miles NW. of Salmon, G. & P. R. R.
    Pre-Cambrian schist cut by granite.
    Veins.
    Min. Res. 1907, pt. 1, p. 320.
    1908, pt. 1, p. 427.
    Umpleby, J. B., Bull. 528, pp. 157–158, 1913.

89. Forney (Gravel Range). Au, Ag (D, Pl.).
    46 miles SW. of Salmon, G. & P. R. R.
    Tertiary volcanics.
    Veins.
    Min. Res. 1905, p. 236.
    1907, pt. 1, p. 320.
    1908, pt. 1, p. 427.
    1909, pt. 1, p. 350.

89. Forney—Continued.
    Umpleby, J. B., Bull. 528, pp. 174–175, 1913.
    Carr, H. C., Vein structure in the Monument mine. Mining Scientific Press, vol. 98, pp. 557–558, 1909.

90. McDevitt. Au (D, Pl.).
    Sunfield station, G. & P. R. R.
    Pre-Cambrian schists.
    Veins, stream gravels.
    Min. Res. 1905, p. 236.
    1909, pt. 1, p. 351.
    Umpleby, J. B., Bull. 528, pp. 118–119, 1913.

91. Gibbonsville. Au, Ag (D, Pl.).
    Station, G. & P. R. R.
    Pre-Cambrian slates.
    Veins.
    Lindgren, W., Bull. 213, pp. 66–70, 1903.
    ——— P. P. 27, p. 90, 1904.
    Bacorn, H. C., A complicated Fault system. Eng. & Mining Journ., vol. 79, p. 324, 1905.
    Lincoln, F. C., Gold deposits of Gibbonsville, Idaho. Mining Sci. Press., vol. 105, pp. 47–49, 1912.
    Umpleby, J. B., Bull. 528, 1913.

92. Indian Creek (Ulysses). Au, Ag, Cu.
    17 miles WNW. of Noble, G. & P. R. R.
    Pre-Cambrian schist cut by granitic dikes.
    Veins.
    Min. Res. 1905, p. 236.
    1906, pp. 260–261.
    1907, pt. 1, p. 320.
    1908, pt. 1, p. 427.
    1909, pt. 1, p. 350.
    Umpleby, Bull. 528, pp. 137–138, 1913.

93. Junction. Pb, Ag.
    Station, G. & P. R. R.
    Paleozoic sediments cut by acidic intrusions.
    Veins.
    Min. Res. 1907, pt. 1, p. 302.
    1908, pt. 1, p. 428.
    1909, pt. 1, p. 350.
    Umpleby, J. B., Bull. 528, pp. 114–115, 1913.

94. Kirtley Creek. Au (Pl, D.).
    10 miles East of Sunfield, G. & P. R. R.
    Pre-Cambrian shists cut by basic dikes.
    Veins, stream gravels.
    Min. Res. 1907, pt. 1, pp. 302–303.
    1908, pt. 1, p. 428.
    Umpleby, J. B., Bull. 528, pp. 124–125, 1913.

95. Leesburg (Arnett Creek). Au (Pl. D.).
    16 miles west of Salmon, G. & P. R. R.
    Pre-Cambrian schists cut by granite.
    Veins, stream gravels.
    Min. Res. 1905, p. 236.
    1907, pt. 1, p. 303.
    1908, pt. 1, p. 428.
    Umpleby, J. B., Bull. 528, p. 148, 1913.

96. Mackinaw. Au, Ag (Pl. D.).
    20 miles NW. of Salmon, G. & P. R. R.
    Pre-Cambrian complex cut by granite.
    Veins, stream gravels.
    Min. Res. 1907, pt. 1, p. 303.
        1908, pt. 1, p. 428.
        1909, pt. 1, p. 350.
    Umpleby, J. B., Bull. 528, pp. 150–152, 1913.
97. Mineral Hill (Shoup). Au (D, Pl.).
    13 miles west of Noble, G. & P. R. R.
    Gneiss cut by granite porphyry and diorite.
    Veins, stream gravels.
    Lindgren, W., P. P. 27, pp. 66, 89–90, 1904.
    Min. Res. 1905, p. 236.
        1906, p. 261.
        1907, pt. 1, p. 303.
        1908, pt. 1, p. 428.
        1909, pt. 1, p. 351.
    Umpleby, J. B., Bull. 528, pp. 140, 141, 1913.
98. Parker Mountain. Ag, Au.
    75 miles SW. of Salmon. G. & P. R. R.
    Tertiary volcanics.
    Veins.
    Min. Res. 1905, p. 236.
        1906, p. 261.
        1907, pt. 1, pp. 303–304.
        1908, pt. 1, p. 428.
    Umpleby, J. B., Bull. 528, pp. 177–178, 1913
99. Pratt Creek. Au, Ag, Pb (Pl, D.).
    10 miles east of Baker, G. & P. R. R.
    Pre-Cambrian schist.
    Veins, stream gravels.
    Min. Res. 1908, pt. 1, p. 428.
    Umpleby, J. B., Bull. 528, p. 121, 1913.
100. Spring Mountain. Pb, Ag, Cu, Au.
    38 miles SSE. Junction. G. & P. R. R., 60 miles NE. of Mackey, O. S. L. R. R.
    Paleozoic sediments, cut by diorite.
    Veins and replacements.
    Min. Res. 1887, p. 107.
        1907, pt. 1, p. 303.
        1908, pt. 1, p. 428.
        1909, pt. 1, p. 351.
    Umpleby, J. B., Bull. 528, pp. 86–87, 1913.
101. Texas Creek (Gilmore). Pb, Ag, Au.
    19 miles south of Junction, G. & P. R. R., 80 miles NNW. Dubois, O. S. L. R. R.
    Paleozoic sediments cut by basic dikes.
    Veins and replacements.
    Min. Res. 1905, pp. 235–236.
        1906, pp. 261, 446.
        1907, pt. 1, p. 303.

101. Texas Creek—Continued.
  Min. Res. 1908, pt. 1, p. 428.
    1909, pt. 1, p. 351.
  Umpleby, J. B., Bull. 528, pp. 104–110, 1913.
  Nichols, Ralph, Lead-silver mines of Gilmore, Lemhi Co., Idaho. Amer. Inst. Mining. Eng., Bull., vol. 83, pp. 2625–2627, 1913, Trans., vol. 46, pp. 937–939, 1914.
  Shannon, Earl V., Ludwigites from Idaho and Korea. Proc. U. S. Nat. Museum, vol. 59, pp. 667–676, 1921.

102. Yellowjacket. Au (D. Pl).
  58 miles WSW. of Salmon, G. & P. R. R.
  Schist (Precambrian?) cut by rhyolite and andesite-porphyry and minette.
  Veins.
  Eldridge, G. H., Sixteenth Ann. Rept., pt. 2, pp. 259–264, 1895.
  Min. Res. 1905, p. 236.
    1906, p. 261.
    1907, pt. 1, p. 304.
    1908, pt. 1, p. 428.
    1909, pt. 1, p. 351.

Owyhee County

Brown, H. S., and Mudgett, F. G., The De Lamar mine of Southwestern Idaho. Calif. Journ. Technology, vol. 12, pp. 35–41, 1908.

Gale, Hoyt S., Nitrate deposits. U. S. Geol. Survey, Bull. 523, p. 36, 1912.

Mansfield, G. R., Nitrate deposits in southern Idaho and eastern Oregon. Bull. 620, pp. 19–44, 1915.

Shannon, Earl V., On the occurrence of ilvaite in the South Mountain district, Owyhee County, Idaho. Amer. Journ. Sci., vol. 45, pp. 118–125, 1918.

——— The occurrence of bindheimite as an ore mineral. Economic Geology, vol. 15, pp. 88–93, 1920.

——— Boulangerite, bismutoplagionite, naumannite, and a silver-bearing variety of jamesonite. Proc. U. S. Nat. Museum, vol. 58, pp. 589–607, 1920.

——— An occurrence of naumannite in Idaho. Amer. Journ. Sci., vol. 50, pp. 589–607, 1920.

——— Owyheeite. Amer. Mineralogist, vol. 6, pp. 82–83, 1921.

——— Notes on the mineralogy of three gouge clays from precious metal veins. Proc. U. S. Nat. Museum, vol. 62, art. 15, 1922.

107. Carson (War Eagle, Silver City, Florida Mountain). Ag, Au.
  23 miles SSW. of Murphy, I. N. R. R.
  Granite and Tertiary volcanics.
  Veins.
  Lindgren, W., The Gold and silver veins of Silver City, De Lamar, and other mining districts in Idaho. Twentieth Ann. Rept., pt. 3, pp. 146–157, 1900.
  Min. Res. 1905, pp. 237–238.
    1906, pp. 262–264.
    1907, pt. 1, p. 305.
    1908, pt. 1, pp. 429–430.
    1909, pt. 1, p. 352.
  Top. sheet Silver City.
  Folio, 104, 1904.

108. De Lamar. Au, Ag.
31 miles SSW. Murphy, I. N. R. R.
Tertiary volcanics.
Veins.
Eldridge, G. H., A geological reconnaissance across Idaho. Sixteenth Ann. Rept., pt. 2, 1895, pp. 271–274.
Lindgren, W., The gold and silver veins of Silver City, De Lamar, and other mining districts in Idaho. Twentieth Ann. Rept., pt. 3, 1900, pp. 106–147.
Min. Res., 1907, pt. 1, p. 305.
1908, pt. 1, pp. 429–430.
Top. sheet Silver City.
Folio 104, 1904.

109. Flint. Ag, Au.
40 miles SSW. of Murphy, I. N. R. R.
Granite and diorite.
Veins.
Lindgren, W., The gold and silver veins of Silver City, De Lamar, and other mining districts in Idaho. Twentieth Ann. Rept., pt. 3, 1900, pp. 187–199.
Min. Res. 1909, pt. 1, p. 352.

110. Mammoth. Au, Ag.
33 miles SSW. of Murphy, I. N. R. R.
Granite.
Veins.
Lindgren, W., The gold and silver veins of Silver City, De Lamar, and other mining districts in Idaho. Twentieth Ann. Rept., pt. 3, 1900 , p. 188.

111. Snake River Placers. Au (Pl.).
Stream gravels.
Min. Res., 1907, pt. 1, p. 306.
1908, pt. 1, p. 430.
Top. sheet Bisuka, Silver City.
Folio 104, 1904.

112. South Mountain. Pb, Ag, Cu.
46 miles SSW. of Murphy, I. N. R. R.
Schist, diorite, and limestone.
contact metamorphic, veins.
Lindgren, W., The gold and silver veins of Silver City, De Lamar, and other mining districts of Idaho. Twentieth Ann. Rept., p. 3, 1900, p. 188.
Min. Res., 1906, p. 446.
1907, pt. 1, pp. 305–306.
Bell, R. N., South Mountain, Idaho: Eng. & Mining Journ., vol. 83, pp. 283–284, 1907.

Shoshone County

The ore deposits of Shoshone County are nearly all in what is popularly known as the Coeur d'Alene Region or district, which has, for administrative and other purposes, been subdivided into the Beaver, Eagle, Evolution, Hunter, Leland, Pine Creek, Placer Center, St. Regis, Summit, Yreka, and other subdistricts. The following papers apply to several or all of these.

Auerbach, Herbert S., The North Side of the Coeur d'Alene district. Eng. and Mining Journ., vol. 86, pp. 65–70, 1908.

——— Tungsten ore deposits of the Coeur d'Alene. Eng. and Mining Journ., vol. 86, pp. 1146–1148, 1908.

Calkins, F. C., Geology and ore deposits of the Coeur d'Alene (discussion). Econ. Geology, vol. 4, pp. 258–261, 1909.

Finlay, J. R., The mining industry of the Coeur d'Alenes, Idaho. Amer. Inst. Mining Eng., Trans., vol. 33, pp. 235–271, 1903.

Huston, George, Notes on the geology of the Snowstorm mine, Idaho. Eng. and Mining Journ., vol. 90, pp. 1109–1110, 1910.

——— Pritchard formation rocks. Mining World, vol. 36, p. 305, 1912.

——— The copper beds of the Coeur d'Alene. Mining and Sci. Press, vol. 110, pp. 145–147, 1915.

Ingalsbe, F. R., The Coeur d'Alene mining district, Idaho. Eng. Mining Journ., vol. 96, pp. 156–159, 1913.

Ransome, F. L., The Coeur d'Alene district. Mining Mag., vol. 12, pp. 26–32, 1905.

Rowe, J. P., Mining in the Coeur d'Alene district, Idaho. Mines and Minerals, vol. 28, pp. 549, 551, 1908.

——— The Coeur d'Alene mining district, Idaho. Mining World, vol. 29, pp. 739–740, 777–778, 843–845 (1908); vol. 30, pp. 11–14, 89–92, 117–120, 318–320, 357–358, 428–430, 1909.

Wiard, Edward S., Ore dressing in the Coeur d'Alene district, Idaho. Eng. Mining Journ., vol. 88, pp. 1055–1060, 1909.

Allen, R. C., Equipment and methods at the Hecla mine. Eng. Mining Journ., vol. 89, pp. 311–313, 1910.

Hershey, Oscar H., Some Tertiary and Quaternary geology of western Montana, northern Idaho, and eastern Washington. Geol. Soc. Amer., Bull. 23, pp. 517–536, 1912.

——— Genesis of lead-silver ores in Wardner district, Idaho. Mining Sci. Press, vol. 104, pp. 750–743, 786–790, 825–827, 1912.

——— Origin of lead, zinc, and silver in the Coeur d'Alene. Mining Sci. Press, vol. 107, pp. 489–493, 529–533, 1913.

——— Origin and distribution of ore in the Coeur d'Alene, 32 pp. (Private publication, 1916, see Mining Sci. Press, vol. 112, p. 734, 1916.)

——— Genesis of Success zinc-lead deposit (discussion). Econ. Geology, vol. 12, pp. 548–558, 1917.

——— Geology of the Success mine. Mining Sci. Press, vol. 116, p. 470, 1918.

Clayton, Joshua E., The Coeur d'Alene silver-lead mines. Eng. Mining Journ., vol. 45, pp. 108–109, 1888.

Moore, S. R., Geology of the Success mine. Mining Sci. Press, vol. 116, p. 8, 1918.

Umpleby, J. B., Genesis of the Success zinc-lead deposit, Coeur d'Alene district, Idaho. Econ. Geology, vol. 12, pp. 138–153, 1917.

Ray, James C., The copper beds of the Coeur d'Alene. Mining Sci. Press, vol. 110, pp. 299–301, 1915.

Lammers, Theo. L., The Murray gold belt, Idaho. Mining Sci. Press, vol. 94, pp. 636–637, 1907.

Campbell, W., The microstructure of a complex ore from the Frisco mine, Gem, Idaho. Eng. Mining Journ., vol. 87, pp. 260–261, 1909.

Calkins, F. C., and Jones, E. L., jr., Geology of the St. Joe-Clearwater region, Idaho. U. S. Geol. Survey Bull. 530, pp. 75–86, 1913.

——— Economic geology of the region around Mullan, Idaho, and Saltese, Montana. U. S. Geol. Survey Bull. 540, pp. 167–211, 1914.

Shannon, Earl V., Secondary enrichment in the Caledonia mine, Coeur d'Alene district, Idaho. Econ. Geology, vol. 8, pp. 565–570, 1913.

——— On a supposed new occurrence of plattnerite in the Coeur d'Alene. Amer. Journ. Sci., vol. 36, pp. 427–428, 1913.

——— Crystals of pyromorphite. Amer. Journ. Sci., vol. 43, pp. 325–327, 1917.

——— Notes on unusual masses of plattnerite. Amer. Mineralogist, vol. 2, pp. 15–17, 1917.

——— On mullanite, a new member of the jamesonite group from two localities. Amer. Journ. Sci., vol. 45, pp. 66–70, 1918.

——— Some minerals from the Stanley antimony mine, Idaho. Amer. Mineralogist, vol. 3, pp. 23–27, 1918.

——— Anglesite from the Coeur d'Alene district, Idaho. Amer. Journ. Sci., vol. 47, pp. 287–292, 1919.

——— Linarite and leadhillite from Idaho. Amer. Mineralogist, vol. 4, pp. 93–94, 1919.

——— The occurrence of bindheimite as an ore mineral. Econ. Geology vol. 15, pp. 88–93, 1920.

——— Petrography of some lamprophyric dike rocks of the Coeur d'Alene district, Idaho. Proc. U. S. Nat. Museum, vol. 57, pp. 475–495, 1920.

——— Notes on anglesite, calcite, tetrahedrite, etc. Proc. U. S. Nat. Museum, vol. 58, pp. 437–453, 1920.

——— Boulangerite, bismutoplagionite, naumannite, and a silver-bearing variety of jamesonite. Proc. U. S. Nat. Museum, vol. 58, pp. 589–607, 1920.

——— Ferroanthophyllite, an orthorhombic iron amphibole from Idaho. Proc. U. S. Nat. Museum, vol. 59, pp. 397–401, 1921.

——— An occurrence of iron-cobalt-bearing gersdorffite from Idaho. Wash. Acad. Sci. Journ., vol. 14, pp. 275–277, 1924.

Hawkins, E. N., and Hawkins, J. D. Plattnerite from Idaho. Amer. Journ. Sci., vol. 38, pp. 165–166, 1889.

Wheeler, H. A., Plattnerite from Idaho. Amer. Journ. Sci., vol. 38, pp. 79, 1889.

Yeates, Wm. S., Plattnerite and its occurrence near Mullan, Idaho. Amer. Journ. Sci., vol. 43, pp. 407–412, 1892.

Stewart, Chas. A., A comparison of the Coeur d'Alene monzonite with other plutonic rocks of Idaho. Journ. Geology, vol. 22, pp. 684–688, 1914.

Jones, Edw. L., jr., A reconnaissance of the Pine Creek district, Idaho. U. S. Geol. Survey, Bull. 710A, pp. 1–36, 1919.

Umpleby, J. B., and Jones, Edw. L., jr., Geology and ore deposits of Shoshone County, Idaho. U. S. Geol. Survey Bull. 732, pp. 1–156, 1923.

113. Bald Mountain (Monitor). Cu, Au.
 5½ miles west of Saltese, Mont. N. P. R. R., C. M. & St. P. R. R.
 Pre-Cambrian sediments cut by diabase.
 Veins.
 Collier, A. J., Ore deposits in the St. Joe River Basin, Idaho. Bull. 285, 1906, pp. 135–136.
 Pardee, J. T., Geology and mineralization of the upper St. Joe River Basin, Idaho. Bull. 470, 1911, pp. 39–61.
 Top. sheet Avery.

114. Beaver (Coeur d' Alene). Pb, Ag, Cu, Au, (D. Pl.).
 4 miles northwest of Burke, N. P. R. R.
 Pre-Cambrian sediments.
 Veins.
 Ransome, F. L., Ore deposits of the Coeur d'Alene district, Idaho. Bull. 260, 1905, pp. 274–303.

114. Beaver—Continued.
Ransome, F. L., and Calkins, F. C., The geology and ore deposits of the Coeur d'Alene district, Idaho. P. P. 62, 1908.
Min. Res. 1905, p. 240.
1906, pp. 264, 445–446.
1907, pt. 1, p. 308.
1908, pt. 1, p. 431.
1909, pt. 1, pp. 353–354.
Umpleby & Jones, Bull. 732, above.
U. S. Bureau of Mines, Bull. 166, p. 19, 1919.
Top sheet, Coeur d'Alene special.

115. Black Prince. Cu.
St. Joe station, C. M. & St. P. R. R.
Pre-Cambrian quartzite cut by granite.
Veins.
Collier, A. J., Bull. 285 (above), 1906, p. 136.
Pardee, J. T., Bull. 470 (above), 1911, pp. 39–61.
Top. sheet, Avery.

116. Eagle (Murray, Coeur d'Alene). Au, (Pb, Ag).
Paragon station, I. N. R. R.
Pre-Cambrian sediments cut by acidic intrusives.
Veins.
Lindgren, W., A geological reconnaissance across the Bitterroot Range and Clearwater Mountains in Montana and Idaho. P. P. 27, pp. 108–111, 1904.
Ransome, F. L., Bull. 260 (above), pp. 274–303, 1905.
Ransome and Calkins. P. P. 62 (above), 1908.
Min. Res. 1905, p. 240.
1906, pp. 264, 445–446.
1907, pt. 1, p. 308.
1908, pt. 1, p. 431.
1909, pt. 1, pp. 354, 579.
Top. sheet, Coeur d'Alene special.

117. Evolution (Coeur d'Alene). Pb, Ag, Cu, Au.
Kellogg station, O. W. R. & N. R. R.
Pre-Cambrian sediments.
Veins.
Ransome, F. L., Bull. 260, pp. 274–303 (above), 1905.
Ransome and Calkins, P. P. 62 (above), 1908.
Umpleby and Jones (above), Bull. 732, 1923.
Min. Res. 1905, p. 240.
1906, pp. 264, 445, 446.
1908, pt. 1, p. 432.
1909, pt. 1, p. 354.
U. S. Bureau of Mines, Bull. 166, p. 19, 1919.
Top, sheet, Coeur d'Alene special.

118. Hunter (Mullan, Coeur d'Alene). Pb, Ag, Cu, Au.
Mullan station, N. P. R. R.
Pre-Cambrian sediments.
Veins.
Ransome (above), Bull. 260, pp. 274–303, 1905.
Ransome and Calkins (above), P. P. 62, 1908.
Calkins and Jones (above), Bull. 540. pp. 167–211, 1914.
U. S. Bureau of Mines, Bull. 166, p. 20, 1919.

118. Hunter—Continued.
   Min. Res. 1905, p. 240.
      1906, pp. 264, 445–446.
      1907, pt. 1, pp. 308–309.
      1908, pt. 1, pp. 207–208, 432–433.
      1909, pt. 1, pp. 354–355.
   Top. sheet Coeur d'Alene special.

119. Leland (Burke, Coeur d'Alene). Pb, Ag, Au, Cu, Zn.
   Burke station, N. P. R. R.
   Pre-Cambrian sediments cut by monozonite.
   Veins.
   Ransome, F. L. (above), Bull. 260, 1905, pp. 274–303.
   Ransome and Calkins (above), P. P. 62, 1908.
   Umpleby and Jones (above), Bull. 732, 1923.
   U. S. Bureau of Mines Bull. 166, 1919.
   Min. Res. 1905, pp. 240–250.
      1906, pp. 264–265, 445–446.
      1907, pt. 1, pp. 309–310.
      1908, pt. 1, p. 433.
      1909, pt. 1, pp. 355–356.
   Top. sheet Coeur d'Alene special.

120. Pine Creek. Pb, Ag, Zn.
   12 miles SSE. Kingston, O. W. R. & N. R. R.
   Pre-Cambrian sediments.
   Veins.
   Calkins, F. C., and MacDonald, D. F., A geological reconnaissance in northern Idaho and northwestern Montana. Bull. 384, 1909, pp. 94–95.
   Jones, E. L. jr., A reconnaissance of the Pine Creek district, Idaho. Bull. 710A, pp. 1–36, 1919.
   Brainard, Robt. I., Antimony mining in the Coeur d'Alene district, Idaho. Mining World, vol. 44, pp. 351–353, 1916.
   U. S. Bureau of Mines Bull. 166, p. 21, 1919.
   Top. sheet, Cataldo.

121. Placer Center (Wallace, Coeur d'Alene). Pb, Ag, Cu, Zn, W.
   Wallace station, N. P. R. R.
   Pre-Cambrian sediments cut by monzonite.
   Veins.
   Lindgren, W. (above), P. P. 27, pp. 108–111, 1904.
   Ransome, F. L. (above), Bull. 260, pp. 274–303, 1905.
   Ransome and Calkins (above), P. P. 62, 1908.
   Min. Res. 1905, p. 241.
      1906, pp. 265, 445–446.
      1907, pt. 1, p. 310.
      1908, pt. 1, pp. 434, 723.
      1909, pt. 1, p. 356.
   U. S. Bur. Mines, Bull. 166, p. 22, 1919.
   Top. sheet, Coeur d'Alene special.

122. Slate Creek. Pb, Ag.
   15 miles south of Wallace, N. P. R. R.
   Pre-Cambrian sediments cut by acidic intrusives.
   Replacements and veins.
   Collier, A. J., Ore deposits of the St. Joe River Basin, Idaho. Bull. 285, 1906, pp. 133–134.
   Calkins and Jones (above), Bull. 530, 1913.
   U. S. Bureau of mines, Bull. 166, p. 25, 1919.

124. St. Joe. Au (Pl).
25 miles west of Iron Mountain, Mont. N. P. R. R.
Stream gravels.
Calkins and Jones (above), Bull. 530, 1912.
Collier (above), Bull. 285, 1906.
Pardee (above), Bull. 470, 1911.
Min. Res. 1909, pt. 1, p. 356.
U. S. Bureau of Mines, Bull. 166 p. 24, 1919.

125. St. Regis (Coeur d'Alene). Au, Cu.
Lookout Station, N. P. R. R.
Pre-Cambrian sediments.
Veins.
Calkins, F. C., and Jones, E. L. jr., Economic geology of the region around Mullan, Idaho, and Saltese, Mont. Bull. 540, pp. 167–211, 1912.
Ransome, F. L., Ore deposits of the Coeur d'Alene district, Idaho. Bull. 260, 1905, pp. 274–303.
Ransome, F. L. and Calkins, F. C. (above), P. P. 62, 1908.
Min. Res. 1905, p. 241.
1906, pp. 266, 445–446.
1907, pt. 1, p. 310.
Top. sheet, Coeur d'Alene special.

126. Summit (Coeur d'Alene). Au, Pb, Cu, Ag.
10 miles SE. of Paragon, I. N. R. R.
Pre-Cambrian sediments.
Veins.
Ransome, F. L. (above), Bull. 260, 1905, pp. 274–303.
Ransome, F. L., and Calkins, F. C. (above), P. P. 62, 1908.
U. S. Bureau of Mines, Bull. 166, p. 22, 1919.
Min. Res. 1905, p. 241.
1906, pp. 266, 445–446.
1907, pt. 1, pp. 310–311, 712.
1908, pt. 1, p. 434.
Top. sheet Coeur d'Alene special.

127. Yreka (Wardner, Coeur d'Alene). Pb, Ag, Au, Cu.
Kellogg station, O. W. R. & N. R. R.
Pre-Cambrian sediments.
Veins.
Lindgren, W., P. P. 27, pp. 108–111 1904.
Ransome, F. L., Bull. 260, 1905, pp. 274–303.
Ransome, F. L. and Calkins F. C., P. P. 62, 1908.
Umpleby, J. B., and Jones, E. L. Bull. 723, 1923.
Min. Res. 1885, p. 387,
1886, p. 146.
1887, pp. 107–109.
1888, pp. 88–89.
1905, p. 241.
1906, pp. 266, 445–446.
1908, pt. 1, p. 434.
1909, pt. 1, p. 356–357.
McCormick, E., The ore deposits of Yreka mining district, Idaho. Eng. Mining Journ., vol. 69, p. 404, 1900.

Washington and Adams Counties

Reid, G. D., The Seven Devils and Snake River district. Eng. and Mining Journ., vol. 84, pp. 401–402, 1907.

Packard, R. L., On an occurrence of copper in western Idaho. Amer. Journ. Sci., vol. 50, pp. 298–300, 1895.

Bell, R. N., Sapphires in Idaho. Mining World, vol. 26, p. 449, 1907.

128. Black Lake. Au (D, Pl.).
    40 miles NNW. Council, P. & I. N. R. R.
    Min. Res. 1905, p. 242.
    1906, p. 267.

129. Heath. Cu, Ag, Au.
    24 miles NW. Cambridge, P. & I. N. R. R.
    Triassic(?) sediments cut by diorite(?).
    Contact metamorphic(?).
    Lindgren, W., The gold and silver veins of De Lamar, Silver City, and other mining districts in Idaho. Twentieth Ann. Rept., pt. 3, 1900, pp. 253–254.
    Idaho Bur. Mines & Geol., Bull. 1, pp. 83, etc. 1920.
    Min. Res. 1882, p. 229.
    1906, p. 267.

130. Meadows. Au (Pl.).
    16 miles NE. Evergreen, P. & I. N. R. R.
    Min. Res. 1905, p. 242.
    1906, p. 267.

131. Mineral. Pb, Ag, Cu, Au.
    29 miles NNE. Huntington, Oreg., O. W. R. R. & N. Co.
    Greenstones, quartz diorite.
    Replacements, veins.
    Lindgren, W., The Gold belt of the Blue Mountains in Oregon. 22nd. Ann. Rept., pt. 2, 1901, pp. 754–756.
    Turner, H. W., The ore deposits at Mineral, Idaho. Econ. Geology, vol. 3, pp. 492–502, 1908.

132. Monroe Creek (Weiser). Au. (D. Pl.).
    10 miles north of Weiser, O. S. L. R. R.; O. W. R. & N. R. R.
    Top. sheet Weiser.

133. Placer Basin. Au.
    37 miles NNE. of Council, P. & I. N. R. R.
    Veins.
    Lindgren, W., The gold and silver veins of Silver City, De Lamar, and other mining districts in Idaho. Twentieth Ann. Rept., pt. 3, p. 253, 1900.

134. Seven Devils. Cu, Au, Ag.
    37 miles NW. of Council, P. & I. N. R. R.
    Triassic (?) sediments cut by diorite.
    Contact metamorphic.
    Lindgren, W., The gold and silver veins of Silver City, De Lamar, and other mining districts in Idaho. Twentieth Ann. Rept., pt. 3, p. 249, 1900.
    Weed, W. H., The copper mines of the United States in 1905. Bull. 285, 1906, pp. 108–109.

134. Seven Devils—Continued.

Min. Res. 1898 (20th Ann. Rept., pt. 6), pp. 182–184.
1905, p. 242.
1906, p. 267.
1907, pt. 1, p. 312.
1908, pt. 1, p. 435.
1909, pt. 1, p. 357.

Beals, Wm., jr., The Seven Devils Mining district, Idaho. Eng. Mining Journ., vol. 69, pp. 345–346, 1900.

Palache, Chas., Note on epidote and garnet from Idaho. Amer. Journ. Sci., vol. 8, pp. 299–302, 1899.

Melville, W. H., Powellite-calcium molybdate; a new mineral species. Amer. Journ. Sci., vol. 41, pp. 138–141, 1891.

Livingston, D. C., and Laney, F. B., The copper deposits of the Seven Devils and adjacent districts. Idaho Bureau of Mines and Geology, Bull. 1, 1920.

CLASSIFICATION OF THE VALUABLE MINERALS

Inasmuch as the present volume is primarily a mineralogical compilation, no section is specifically dedicated to a discussion of the occurrence of the several valuable metals which are mined in the State. The available information regarding the distribution and occurrence of these metals is, however, pretty thoroughly presented in discussion of the occurrence of the minerals themselves. Thus the gold mines of the State are discussed under native gold, since this is practically the only important gold mineral. Similarly, the lead deposits of the area are described under galena and cerusite, the two most important minerals of the ores of that metal. As a guide to assist in finding information relative to the distribution of the metallic ores, the following classification of the minerals is presented, arranged according to their metallic constituents.

ANTIMONY

Stibnite, antimony sulphide.
Kermesite, antimony oxysulphide.
Jamesonite, lead-antimony sulphide.
Miargyrite, silver-antimony sulphide.
Pyrargyrite, silver-antimony sulphide.
Stephanite, silver-antimony sulphide.
Polybasite, silver-antimony sulphide.
Owyheeite, lead-silver antimony sulphide.
Boulangerite, lead-antimony sulphide.
Tetrahedrite, copper-antimony sulphide.
Cervantite, antimony oxide.
Stibiconite, antimony oxide.
Valentinite, antimony oxide.
Bindheimite, lead antimony oxide.

ARSENIC

Realgar, arsenic sulphide.
Cobaltite, cobalt-arsenic sulphide.
Arsenopyrite, iron-arsenic sulphide.
Niccolite, nickel arsenide.

Smaltite, cobalt arsenide.
Proustite, silver arsenic sulphide.
Enargite, copper-arsenic sulphide.
Tennantite, copper-arsenic sulphide.
Erythrite, cobalt-arsenic oxide.
Scorodite, iron-arsenic oxide.
Annabergite, nickel-arsenic oxide.
Mimetite, lead-arsenic oxide.

BARIUM

Barite, barium sulphate.

BERYLLIUM

Beryl, beryllium-aluminium silicate.

BISMUTH

Bismuth.
Bismuthinite, bismuth sulphide.
Galenobismutite, bismuth-lead sulphide.
Aikinite, bismuth-lead-copper sulphide.
Tetradymite, bismuth telluride.
Guanajuatite, bismuth selenide.
Bismutosphaerite, bismuth carbonate.
Bismutite, bismuth carbonate.

BORON

Tourmaline, iron-aluminium-boron, etc., silicate.
Ludwigite, magnesia-iron borate.

CADMIUM

Greenockite, cadmium sulphide.

CERIUM

Monazite, cerium phosphate.
Also samarskite, gadolinite, aeschynite, polycrase, etc.

CHROMIUM

Chromite, chromium-iron oxide.

COBALT

Cobaltite, cobalt-arsenic sulphide.
Smaltite, cobalt arsenide.
Danaite, iron cobalt-arsenic sulphide.
Gersdorffite, iron-nickel-cobalt-arsenic sulphide.
Erythrite, cobalt-arsenic-oxide.
Asbolite, cobalt-manganese oxide.

COPPER

Native copper.
Chalcocite, copper sulphide.
Covellite, copper sulphide.
Stromeyerite, copper-silver sulphide.
Bornite, copper-iron sulphide.
Chalcopyrite, copper-iron sulphide.
Tetrahedrite, copper-antimony sulphide.
Tennantite, copper-arsenic sulphide.
Enargite, copper-arsenic sulphide.
Cuprite, copper oxide.
Melaconite, copper oxide.
Malachite, copper carbonate.

Azurite, copper carbonate.
Aurichalcite, copper-zinc carbonate.
Chrysocolla, copper silicate.
Copper pitch, copper silicate.
Caledonite, copper-lead sulphate.
Linarite, copper-lead sulphate.
Chalcanthite, copper sulphate.
Brochantite, copper sulphate.

COLUMBIUM

Columbite, iron columbate.
Samarskite, rare earth columbate.
Polycrase, rare earth columbate.
Euxenite, rare earth columbate.

GOLD

Native gold.
Sylvanite, gold-silver telluride.
Calaverite, gold telluride.

IRON

Metallic iron (meteorite).
Pyrrhotite, iron sulphide.
Bornite, copper-iron sulphide.
Chalcopyrite, copper-iron sulphide.
Marcasite, iron sulphide.
Pyrite, iron sulphide.
Arsenopyrite, arsenic-iron sulphide.
Hematite, iron oxide.
Ilmenite, iron-titanium oxide.
Magnetite, iron oxide.
Chromite, iron-chromium oxide.
Turgite, hydrous iron oxide.
Goethite, hydrous iron oxide.
Limonite, hydrous iron oxide.
Ankerite, magnesium-iron carbonate.
Siderite, iron carbonate.

LEAD

Native lead.
Galena, lead sulphide.
Jamesonite. lead-antimony sulphide.
Boulangerite, lead-antimony sulphide.
Owyheeite, lead-silver-antimony sulphide.
Massicot, lead oxide.
Minium, lead oxide.
Cerusite, lead carbonate.
Plattnerite, lead dioxide.
Pyromorphite, lead phosphate.
Mimetite, lead arsenate.
Vanadinite, lead vanadate.
Bindheimite, lead antimonate.
Wulfenite, lead molybdate.
Anglesite, lead sulphate.
Leadhillite, lead sulphate-carbonate.
Caledonite, lead-copper sulphate.
Linarite, lead-copper sulphate.

MANGANESE

Braunite, manganese oxide.
Psilomelane, manganese oxide.
Pyrolusite, manganese oxide.
Rhodochrosite, manganese carbonate.

MERCURY

Cinnabar, mercury sulphide.

MOLYBDENUM

Molybdenite, molybdenum sulphide.
Molybdite, iron molybdate.
Wulfenite, lead molybdate.
Powellite, calcium molybdate.

NICKEL

Gersdorffite, nickel-iron-cobalt-arsenic sulphide.

PHOSPHOROUS

Apatite, calcium phosphate.
Phosphorite, calcium phosphate.
Collophane, calcium phosphate.
Pyromorphite, lead phosphate.
Vivianite, iron phosphate.
Evansite, aluminium phosphate.

PLATINUM

Metallic platinum.

SELENIUM

Naumannite, silver selenide.
Guanajuatite, bismuth selenide.

SILVER

Metallic silver.
Argentite, silver sulphide.
Naumannite, silver selenide.
Stromeyerite, silver-copper sulphide.
Miargyrite, silver-antimony sulphide.
Pyrostilpnite, silver-antimony sulphide.
Pyrargyrite, silver-antimony sulphide.
Stephanite, silver-antimony sulphide.
Polybasite, silver-antimony sulphide.
Owheeite, silver-lead-antimony sulphide.
Proustite, silver-arsenic sulphide.
Xanthaconite, silver-arsenic sulphide.
Cerargyrite, silver chloride.
Embolite, silver bromide.

TELLURIUM

Sylvanite, gold-silver telluride.
Calaverite, gold-silver telluride.
Tetradymite, bismuth telluride.

THORIUM

Monazite, cerium phosphate containing thorium.
Polycrase.
Samarskite.
Brannerite, etc.

TIN

Cassiterite, tin dioxide.

TITANIUM

Rutile, titanium dioxide.
Ilmenite, iron-titanium oxide.
Titanite, calcium-titanium silicate.
Brannerite, uranium titanate.
Also the rare earth minerals, polycrase, euxenite, samarskite, etc.

TUNGSTEN

Wolframite, iron-manganese tungstate.
Ferberite, iron tungstate.
Hubnerite, manganese tungstate.
Scheelite, calcium tungstate.
Tungstite, tungsten oxide.

URANIUM

Samarskite.
Brannerite.
Polycrase, etc.

ZINC

Sphalerite, zinc sulphide.
Wurtzite, zinc sulphide.
Smithsonite, zinc carbonate.
Aurichalcite, zinc-copper carbonate.
Calamine, zinc silicate.

ZIRCONIUM

Zircon, zirconium silicate.

DESCRIPTIONS OF MINERALS

DIAMOND (1)

Carbon, C. Isometric.

ADAMS COUNTY

Diamonds have been authentically reported to occur in Idaho only in the Rock Flat gold mine in Adams County at the head of Little Goose Creek Canyon, 5 miles east of New Meadows. Here three small crystals were found in heavy concentrates from a testing operation on several cubic meters of the gravel. The largest of the diamonds was an almost perfect octahedron weighing one-third of a carat and having a grayish color and typically greasy luster. The angles were somewhat rounded with a fused appearance. The heavy residue of concentrate from each cubic yard of gravel weighed 90 pounds and, in addition of 15 cents worth of coarse gold, contained 3 per cent of ilmenite, magnetite, and a little chromite, and 20 per cent of zircon sand, and the balance being made up of corundum, garnet, and monazite. Variously colored corundum crystals are common here.[3]

OWYHEE COUNTY

A brief reference in an old Government publication states that diamonds have been reported to exist on Owyhee River[3a]; a few small stones have been reported and probably some were found in the placer mines, under the same conditions and of about the same quality as those in California. Some excitement has occasionally arisen about these Idaho diamonds. In 1864 to 1866 local and mining papers made many references to reported or anticipated discoveries; but nothing of any importance was found. In the winter of 1892–93 the matter again attracted some attention. Only small quartz crystals and no diamonds were found, the name "Diamond Basin" having given color to the reported findings. Diamond Basin lies on the Snake River in Owyhee County. The excitement, intense for a time, subsided before the winter was over.[4]

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[3] Robert N. Bell, 15th Ann. Rept. Idaho State Mine Inspector, pp. 218–219, 1913.

[3a] Wm. P. Blake, Annotated catalogue of the principal mineral species hitherto recognized in California and the adjoining States and Territories. Browne and Taylor, Min. Resources U. S., 1866, p. 201.

It is possible that a few small diamonds may occur in placers in other portions of the State, but the possibility of deposits of stones of gem quality being found is very remote. The source of the Rock Flat crystals is not known, but the fact that chromite and a trace of platinum have been reported from the same claim may indicate their derivation from a small intrusive mass of peridotite. Scattered stones have been found from time to time in the gold placers of California, but no diamond deposits have been found in that State in which the geological environment is, on the whole, much more favorable for the occurrence of this mineral.

GRAPHITE (2)

PLUMBAGO, BLACK LEAD

Carbon, C. Hexagonal.

The black hexagonal form of carbon, graphite, is not abundant in Idaho and no deposits of commercial importance are known there. The most common occurrence of this mineral is as a very finely disseminated coloring matter in slaty rocks in various parts of the State as, for example, the Prichard formation in the Coeur d'Alene district and the ore-bearing Devonian slates of the Wood River district in Blaine County.

ADAMS COUNTY

Graphite has been mentioned as occurring in the Seven Devils district as a minor constituent of the ores in some of the contact-metamorphic copper deposits.

BLAINE COUNTY

Some attempt has been made at exploring certain graphite-rich streaks in the graphitic slates of the Devonian formation on Trail Creek at the town of Ketchum on upper Wood River. The claims opened by Messrs. Hampton and Griffith in 1908 and a small production of amorphous graphite was reported in 1909 but nothing since.[5]

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[4] George F. Kunz, Precious stones. U. S. Geol. Survey, Mineral Resources for 1892, p. 759.

[5] U. S. Geol. Survey, Mineral Resources, 1913, pt. 2, p. 199.

BUTTE COUNTY

B. F. Morrison of Martin, Butte County, has submitted a black highly polished sheared graphitic shale.

CUSTER COUNTY

A specimen of graphitic schist containing clean-cut crystalline flakes of graphite has been sent to the National Museum by a correspondent in Challis, Idaho. The material is similar to the rock mined for graphite in some localities in the Appalachian States. It is not definitely known that the rock is from Idaho and inquiries regarding it have not been answered. Other specimens sent in for examination by Guy E. Matthews, of Boise, and said to have come from a large ledge near the summit of the Sawtooth Mountains, consist of small hexagonal scales thickly disseminated in quartzite and of reddish black smears on sheared quartz schist.

CAMAS COUNTY

A sample of impure fine-grained graphite has been submitted to the Museum for identification by John F. Williams from Fairfield, Camas County.

IDAHO COUNTY

Graphitic schists are reported to occur on Salmon River near Grangeville. Analysis of a specimen of the material showed 7.6 per cent of fixed carbon.[6]

SULPHUR (3)

Sulphur, S. Orthorhombic.

ADAMS COUNTY

In the Red Ledge mine, in the Seven Devils district, sulphur occurs in crusts, often 2 centimeters or more thick, mixed with the sulphates melanterite, pisanite, and chalcanthite. Steep, vertical cliffs of quartz monzonite are stained bright red by hematite and perhaps a little cuprite from the oxidation of pyrite and chalcopyrite disseminated through the rock. Small caves at the base of the cliffs contain crusts of soluble sulphates and sulphur, often several centimeters thick, the sulphates having been carried downward by percolating waters from the sulphide-impregnated rock. The sulphur has doubtless been produced by decomposition of the sulphates.

BANNOCK COUNTY

Sulphur in native form occurs abundantly 5 miles east of Soda Springs on the Oregon Short Line Railroad. An attempt was made to work these deposits in the late nineties, and a considerable amount of sulphur was produced in 1901 and 1902, but the plan was abandoned and the plant was dismantled in 1910. Exploitation was again begun in 1918. The sulphur occurs in connection with a group of sulphur springs, which range from the size of a washbasin to some which are large enough for a good-sized swimming pool. The water is milky from precipitated sulphur and is acid, much carbon dioxide and hydrogen sulphide being given off. The bulk of the sulphur, which is associated with small crystals of gypsum, forms the cement of a fault agglomerate or breccia composed of fragments of tuff, limestone, and quartzite. Small pyramidal crystals are found lining cavities of crystalline and amorphous masses in the interstices of the breccia. The crystallinity is shown by the spherical radiated figures formed upon some surfaces obtained by breaking, while the smooth or conchoidal fracture on other surfaces serves to indicate the amorphous variety. A rather spectacular form, namely, stalactites in vertical crevices traversing the breccia, occurs in the south wall of the quarry on the Wood Canyon side of the divide. This variety has an almost canary-yellow color on fresh fracture, which changes rapidly on exposure to dull, submetallic gray. Much of the low-grade ore also has this gray color. Air bubbles in many of the stalactites may indicate that the sulphur was exuded in liquid form. Alum occurs rarely in the deposits.[7]

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[6] U. S. Geol. Survey, Mineral Resources for 1913, pt. 2, p. 199.

BLAINE COUNTY

Powdery sulphur occurs, partly filling little cavities left by the removal of pyrite in quartz of the oxidized portions of the Clipper Bullion vein, Mineral Hill district. This mineral was found by Mr. D. F. Hewett in a prospect 1½ miles southeast of Bellevue associated with anglesite and wulfenite.

CUSTER COUNTY

A specimen of cavernous earthy limonite from the oxidized ore about 30 feet below the surface in the Lost Packer mine contained residual friable masses of chalcopyrite and pale yellow druses of minute crystals of native sulphur.

SHOSHONE COUNTY

Sulphur has been noted in the Caledonia and Hypotheek mines as an alteration product of sulphides in the oxidized ores. In the upper workings of the Caledonia mine native sulphur was a constituent of a yellowish earthy material consisting largely of crushed quartz, with a little limonite and bindheimite. The presence of sulphur in this material was shown by its taking fire and burning with a blue flame when placed on a hot stove. In the Hypotheek mine near Kingston sulphur occurred as minute yellow globules inclosed in transparent anglesite crystals lining cavities in galena.

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[7] R. W. Richards and J. H. Bridges. Sulphur deposits near Soda Springs, Idaho. U. S. Geol. Survey, Bull. 470, pp. 499–503. 1911.

ARSENIC (8)

Arsenic, As. Rhombohedral.

BONNER COUNTY

Arsenic is known to occur only at one locality in a small prospect on Vulcan Hill overlooking North Gold Creek, 2 miles from the town of Lakeview, on Lake Pend d'Oreille. The mineral occurs as a narrow vein in granite near the contact with Cambrian rocks. The arsenic vein is parallel to the galena-bearing vein prospected by the tunnel, and it is reported that where one pinched the other swelled. A very little pyrite, calcite, and epidote are associated with the arsenic. Polished surfaces of the arsenic, when examined with the metallographic microscope, are found to be pure and homogeneous. The material was collected and identified by Edward Sampson, of the United States Geological Survey.

BISMUTH (11)

Bismuth, Bi. Rhombohedral.

CUSTER COUNTY

Bismuth in native form occurs in silver-white to reddish grains disseminated through quartz in the Empire group of claims of the Idaho-Montgomery Mining Co., in Washington Basin at the head of Salmon River. Bismuthinite, barite, pyrrhotite, and pyrite are associated with the bismuth, which is in part altered to bismuth carbonates.

KOOTENAI COUNTY

Bismuth occurs in narrow quartz veins at a contact between granite and slates on Beauty Bay Creek near Beauty Bay on Lake Coeur d'Alene. These veins, which are several in number, cut across the contact from the igneous rock into the sedimentary formation, but are said to contain bismuth only where inclosed in the latter. All of the quartz in the surface workings contains some bismuth in disseminated grains associated with pyrite and a little bismuthinite. Pannings are reported to contain also some gold, silver, and a little tin. One vein of the group contains considerable masses of arsenopyrite and specular hematite.

LEMHI COUNTY

Fine specimens of native bismuth are reported [8] to have come from one of the cobalt mines of the Blackbird district. No information of the mode of occurrence of this material could be obtained.

GOLD (13)

Native Gold, Au. Isometric.

The mining of gold has been in the past, and to a somewhat lesser extent now is, an important industry in the State. Estimates compiled by the United States Geological Survey give the total production in Idaho from the earliest discoveries in 1861 to the end of 1917 as having a mint value of $130,910,969, which amounts to approximately half a million pounds of metallic gold. While many lode mines have been developed in the area and have made large production, the greatest bulk of the gold yield has come from placer mines.

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[8] Robert N. Bell. Personal letter. 1917.

Auriferous veins are widespread in occurrence. The most important mines, however, fall into several groups, the largest group being that in the west-central part of the State mainly in Boise County, but extending into Ada and Elmore counties and including, among others, the Black Hornet, McIntyre (Boise), Gambrinus, Deadwood, Quartzburg-Grimes Pass, Summit Flat (Pioneerville), Westview (Willow Creek or Pearl), Atlanta, Black Warrior, Neal, Pine Grove, and Rocky Bar districts. The country rock in all of these districts is the granite of the western part of the central Idaho batholith and near the veins this granite is usually very greatly altered by thermal solutions with abundant development of sericite. The lodes occur along well-defined fissures and vary from clean cut filled veins to mineralized shear zones containing seams and stringers of auriferous material. The gangue is, for the most part quartz which, where unaffected by oxidation, contains greater or less quantities of sulphides, while in certain mines the sulphides occur as solid masses practically without quartz. At and near the surface the sulphides are in most cases thoroughly oxidised, the ore then consisting of quartz containing much soft and limonitic material which incloses the abundant spongy gold in free milling and easily recoverable form. As greater depth is attained in mining, however, the unaltered primary ore is encountered, in which the gold is associated with or contained in the prevalent sulphides, chief among which are pyrite, arsenopyrite, sphalerite, and galena. Bismuth sulphide or bismuth-lead sulphide (locally called antimonite) are locally characteristic of the richest ores. The primary sulphide ("base" or "refractory") ores are not amenable to the simpler and less expensive methods of treatment and the encountering of such unoxidized ore has led to the temporary or permanent shutdown of a large number of mines in this area.

The second major group of gold lodes is located in Idaho and Clearwater Counties and includes the Elk City, Dewey, Dixie, Florence, Newsome, Oro Grande, Buffalo Hump, Warren, and Pierce districts. These districts are occupied either by the northern continuation of the granitic batholith or by pre-Cambrian metamorphic rocks cut by granitic dikes. In most of the districts of this group the lodes are clean-cut quartz veins without great quantities of sulphides and the gold, even in the unoxidized primary ore, is for the most part free milling.

A third group of gold lodes of various types occurs in Lemhi County near the Montana line, while a fourth small but formerly productive area is in the Coeur d' Alene district in Shoshone County, where the gold occurred in banded quartz veins cutting black Algonkian slates.

The precious metal districts in Owyhee County contain both gold and silver in veins mainly contained in Tertiary volcanic rocks. Similar to these are the deposits of the Thunder Mountain district in Idaho County, the Forney (Gravel Range) and Parker Mountain districts in Lemhi County, and the Yankee Fork district in Custer County. Many of the veins of this group are characterized by crustified quartz, pseudomorphous quartz, or chalcedony, with or without adularia, as gangue. The ores of a number of the mines contain bands of finely divided silver sulphide carrying some selenium. The native gold of these later Tertiary deposits is mostly pale in color and high in silver content, much of it being classifiable as electrum.

Tellurides of gold are of very limited occurrence in the State, practically all of the gold being in native form. Of the rarer minerals accompanying the gold, bismuth sulphide (bismuthinite) and lead-bismuth sulphide (galenobismutite) have been mentioned. Scheelite accompanies the gold in the Charity vein in the Warren district and in several mines in the Coeur d' Alene district.

While no district or mine has attained a reputation for furnishing remarkably showy, beautiful, or well-crystallized specimens of native gold, a majority of the auriferous mines of the State have, at some time during their history, produced ore of such a grade as to make excellent cabinet material. Very few such specimens have been preserved. Descriptions of those in the National Museum collections are given below.

Placer gold was the first form to be mined in the State and the total production of it greatly overshadows that of gold derived from lode mining. Dana, writing in 1890, says of Idaho "Every county in the State yields placer gold." Roughly the great placer regions are the same as those which have been mentioned as the principal groups of lode mining districts, the greatest area being that known as the Boise Basin. Gold occurs in placers in almost every district where auriferous lodes are known, usually in amount out of proportion to the value of the developed veins. Moreover some placer districts of importance have been worked in areas where no productive lodes are known. Such observations as this have given rise, in Idaho as elsewhere, to the fable of the Mother Lode. A sufficient source may be found, however, in the concentration from the disintegration and erosion of quantities of rock measurable in cubic miles including great vertical sections of the known veins, of veins of appreciable gold content yet too low grade to have been worked, and also of inconsequential lenses and stringers of auriferous material which may have added greatly to the total but would not have been of any commercial importance if discovered singly. While the lighter constituents of the rocks have been gradually disintegrated and reduced to fine particles and carried to great distances, the gold and other heavy materials have remained behind. The granite, especially where softened or sericitized by hydrothermal alteration, is prone to be more rapidly removed than the vein quartz which makes up a large proportion of the pebbles in the placer gravels. The more productive placers are, for the most part, along the beds of the present streams, although profitable mines have been worked in high terrace gravels and in fossil stream channels which date from some previous period in the drainage history of the region. The placer gold is concentrated, usually, within a few centimeters or at most a meter of bedrock and is associated with a variety of other heavy minerals. The character of these heavy minerals varies from place to place.[9] Magnetite, ilmenite, and garnet are widespread, while monazite occurs in most of the placer regions in the Central Idaho granitic area, especially in the Boise Basin. Colorless zircon is also abundant, particularly in the Florence and Warren districts. Corundum occurs in considerable quantity near Pierce and Resort in Clearwater County with tourmaline, rutile, and ilmenite, and also at the Rock Flat placer near Meadows in Washington County. The latter locality is that mentioned above as yielding diamonds. Rare earth minerals are known from many places. In addition to the monazite just noted above, brannerite occurs in Stanley Basin, Custer County, and polycrase, samarskite, columbite, etc., are known from several placers in Boise County. Native amalgam occurs in Stanley Basin, while cassiterite and cinnabar have been found here and in the Pierce district. A heavy bismuth carbonate occurs with gold in the Poncia placer, Centerville district, recalling the occurrence of bismuth-bearing sulphides in the Gold Hill, Belzazzar, and other mines.

The richer placers along streams were naturally first discovered and were worked by the simpler hand methods—by panning or with arrastre, rocker, and sluice, and many of them yielded fabulous returns by such methods. The high grade ground suitable for such exploitation was limited, however, and it was necessary to construct larger projects requiring miles of ditches and extensive pipelines to work the higher gravels. Following the bonanza period many of the placer camps were practically abandoned by white men in their rushes to new fields and the only mining for long intervals was that carried on by the patient Chinese. Many of the camps have since become the sites of extensive modern dredging enterprises. Some relatively rich deposits have remained unworked for a variety of reasons—scarcity of water, depth of bedrock, lack of drainage, large size of boulders, shortness of season, or inaccessibility. The available placers of sufficiently high grade to be worked by ordinary methods are, however, pretty well exhausted.

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[9] Earl V. Shannon. Mineralogy of some black sands from Idaho. Proc. U. S. National Museum, vol. 60, art. 3, 1921.

The sands of Snake River contain very finely divided gold in wide distribution. This gold has been mined here and there from the Wyoming line to Oregon. While practically all of the gravels along the river are auriferous, most of the deposits contain so little gold that they can hardly be called placers. Some small deposits yield sufficient to pay for extraction if worked on a large scale and a very few may be worked by hand methods. The problem of saving this gold has been much studied without a practical method being found. The gold is exceedingly finely divided, it requiring fully 1,500 grains or "colors" to weigh 1 cent in value, or approximately 3,000,000 of the grains to weigh one ounce, yet, under the microscope, each grain may be seen to be an individual nugget showing rounding and abrasion marks. The particles are often coated or spotted with a crystalline film of silica, making it necessary to grind the gold in a pan before it will amalgamate freely. In size the particles range within relatively narrow limits and there is no gradual shading from the finer particles into impalpable dust,[10] These Snake River bars have been mined in Ada, Blaine, Bingham, Cassia, and Owyhee Counties.

In composition the gold of both the veins and placers is variable, the variation being in the amount of silver with the gold, there being a transition into electrum, an alloy containing equal molecular parts of gold and silver as discussed below. The lowest grade gold is that of veins in the Tertiary lavas, much of it reaching electrum proportions of silver. In general the gold in the auriferous quartz-sulphide veins in granite is of higher grade, but that in quartz veins free from large amounts of sulphides and inclosed in slates or other metamorphic rocks is of still better grade. Gold in oxidized ore is commonly purer than that in unaltered primary ore, especially if the latter be sulphidic. This is due to the tendency of the silver to be selectively extracted by percolating meteoric waters. As an instance of this may be mentioned the observation of Umpleby[11] that whereas the gold of the primary ore of the Golden Sunbeam mine, Yankee Fork district, Custer County, is electrum, in the oxidized zone native gold and native silver occur in relatively pure form, often side by side, the two metals evidently having separated during the oxidation. Placer gold is commonly purer than that in the veins of the same area. Furthermore the gold of gravel deposits is usually higher in grade the greater the amount of wear and the further it has been transported from its source, which are indicative of the length of time the particles have been exposed to the purifying influences of the ground water. An example of this cited by Lindgren[12] illustrates the progressive refining of the gold in the Warren district. Here vein bullion is 300 to 500 fine (30 to 50 per cent Au), the placer gold in small streams is 650 fine (65 per cent Au), that in the larger streams and main creeks is 725 fine (72.5 per cent Au), while the gold along Salmon River derived from this district is 800 to 825 fine (80 to 82.5 per cent Au). For obvious reasons fine particles of gold are more rapidly purified by this process than are larger nuggets. The purest gold known in the State is the very finely divided "flour" gold of Snake River, all of which is better than 900 fine (90 per cent Au). While the view that placer gold becomes purer by the chemical action of ground water in the gravels is well founded, there is no evidence in support of the common fallacy that nuggets of gold grow by accretion from solutions in the alluvial deposits. In addition to the chemical purification by the above process, long wear by water tends to eliminate impurities mechanically, the pounding tending to crush and expel the brittle gangue minerals such as quartz.

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[10] Robert N Bell. Annual Report of State Inspector of Mines on the Mining Industry of Idaho for 1906 , p. 115.

[11] Joseph B. Umpleby. U. S. Geol. Survey Bull. 539, p. 88, 1913.

Idaho is not known to have produced any exceptionally large masses of placer gold, the maximum recorded weight being in the neighborhood of 40 ounces (Coeur d'Alenes and Idaho Basin). Few samples of placer or lode gold from the State have been available for examination, but such as are in the possession of the National Museum are described below.

In the following outline the most noteworthy gold localities of the State are mentioned, although a detailed discussion of the occurrences of this metal in the State would occupy too much space. The figures of production as given are not extremely modern, many of the records being as old as 1896, and do not take into consideration the production of recent years, which in some cases exceeds that of the earlier period. They serve, however, to indicate the relative commercial importance of the various mines or districts. The arrangement follows the outline given in the list of Idaho mining districts above.[13]

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[12] Waldemar Lindgren. 20th Ann. Rept. U. S. Geol. Survey, pt. 3, p. 242, 1900.

[13] The data given in this outline are not in any sense original, but are compiled, without further specific acknowledgment, from the several works cited in the bibliographic references given, for each of the numerous mining districts, in the preceding pages.

ADA COUNTY

Although the Black Hornet district contains no important placers, a number of veins of gold-bearing quartz occur. Chief among these is the Black Hornet or Ironsides mine which had made a gold production of about $30,000 previous to 1897. The ore consists of quartz containing about 8 per cent of sulphides, chiefly arsenopyrite with less pyrite and sphalerite. Arsenopyrite also occurs in disseminated form in the altered (sericitized) granite of the walls immediately adjacent to the vein.

In the Boise (McIntyre) district a number of auriferous veins have been developed, although there has never been any very great production. Some of the lodes are quartz veins and others are merely altered streaks in the granite along a fault plane. In some cases the values are entirely in gold but some small deposits of rich silver ore have been mined.

In the Snake River placers desultory operations have been carried on from year to year in this county. A dredge capable of handling 1,500 cubic yards of gravel daily was installed in 1907.

BINGHAM AND BONNEVILLE COUNTIES

In the Mount Pisgah district some hydraulic mining has been done at Gray. The gold is 960 fine (96 per cent Au) and is worth $19.84 an ounce.

In the Snake River placers there are a considerable number of small mines. Six operators were working in 1905; a production of 185.22 ounces of gold was reported for 1907, while the output for 1908 and 1909 was worth $2,717 and $1,448, respectively. The gold is 951 fine (95.1 per cent Au) and is valued at $19.66 an ounce.

A sample of heavy concentrate from a Snake River placer mine at Rosa, Bingham County (Cat. 53625 U.S.N.M.) has an average grain diameter of 0.1 mm. and contains a few minute rounded grains of gold associated with abundant ilmenite and augite, occasional almandite and quartz, and rare zircon and olivine.

BLAINE COUNTY

In the Camas district fissure veins in granite carry free native gold with pyrrhotite, pyrite, and chalcopyrite, and less galena, sphalerite and arsenopyrite in a gangue of quartz with some siderite. The principal mines are the Camas No. 2 and the Tip Top. The Camas No. 2 vein produced gold to the value of $58,392.

In the Mineral Hill (Hailey) district the Croesus, Hope, and neighboring veins of what is known as the Hailey gold belt contain their principal values as free gold which is associated with considerable quantities of sulphides, mainly pyrrhotite and chalcopyrite with less galena and sphalerite in a quartz and siderite gangue. These are entirely similar to the deposits of the Camas district, which may be considered as the southwestern continuation of the same zone. They are quite distinct from the lead-silver deposits of the Hailey region.

The Red Warrior district is represented by a number of specimens in the National Museum, as follows: From the Golden Eagle Mine (Cat. No. 65671, U.S.N.M.) coarse native gold in irregular flakes in rusty quartz; from the Wide West mine bluish unoxidised quartz (Cat. No. 65680, U.S.N.M.) containing flakes of pale gold in minute cavities, quartz, with sparsely disseminated pyrite and sphalerite (Cat. No. 14764, U.S.N.M.), and heavy masses of auriferous pyrite and spongy limonite (Cat. No. 14765, U.S.N.M.). Ore from the Victor mine (Cat. No. 14767, U.S.N.M.) consists of coarse comb quartz which is slightly iron stained and that from the Avalanche mine (Cat. No. 14766, U.S.N.M.) consists of bluish auriferous quartz.

The Snake River placers have been mined in Blaine County at Neely resulting in a small production of fine gold. The output was 187 ounces in 1904 and 258 ounces in 1905.

BOISE COUNTY

The Centerville (Idaho Basin) district is one of the most important gold regions of the State. The production from the discovery of the district to 1898 has been estimated at $44,651,800 of which about $4,000,000 was from lode mines and the balance from placers. The gold occurs in recent stream gravels and in terrace or bench gravels at various levels along Grimes, Granite, Moore, and other creeks. Some old stream channels now covered by basalt flows have been mined but have not proven very rich. The highest terrace gravels often contain rounded cobbles of gold-bearing quartz up to 30 cm. in diameter. In a body of gravels immediately east of Idaho City the gold is fairly coarse with a value of $16.50 an ounce before melting. Much of it occurs on bedrock or "false bedrock," the latter being the Payette formation of Tertiary lake sediments which carry a little finely divided pale gold associated with monazite in some layers. The heavy residues associated with the placer gold contain abundant monazite in sharp crystals. Samples from several placers near Centerville and Idaho City, show, in addition to the monazite and the usual garnet, magnetite, ilmenite, etc., larger crystals of polycrase and samarskite, sharp crystals of columbite, and other minerals as described under the separate headings. A sample of pan concentrate from the Leary and Brogan placer, Poncia tract, Centerville, contains all of the above minerals and also heavy pebbles of bismuth carbonate. A specimen of placer gold from near Centerville (Cat. No. 55776, U.S.N.M.) consists of well worn flat flakes of gold uniformly 1 mm. in diameter. Two nuggets from Bill Williams claim (Cat. No. 55464, U.S.N.M.) mined in 1865 are about 1 cm. in diameter and are well-rounded pebbles of dark yellow gold containing some quartz; nuggets of well rounded gold from Bowers Bar, Placerville (Cat. No. 55788, U.S.N.M.) also contain quartz. A specimen from the Green White claim on Moose Creek below Idaho City (Cat. No. 55470, U.S.N.M.) is a pebble about 5 cm. in diameter of equal parts of granular brownish quartz and gold.

In the Deadwood district the Merry Blue and Union mines produced some gold from ore worked in an arrastre in 1907 and 1909.

In the Gold Fork (Roseberry) district placer gold occurs in gravels on McKinley Fork in Long Valley. The Evans and Paddy Valley are the principal gravel mines. The gold is in part well worn, in part rough and attached to quartz. Its source is problematic as no veins are known.

The Quartzburg-Grimes Pass district contains numerous veins of auriferous ore. The Ebenezer claim contained rich surface oxidized ore, but the primary sulphide-bearing ore is very refractory. The Belzazzar mine has galenobismutite (q. v.) associated with the gold in the richest ore. The Gold Hill and Pioneer claims, worked together, form the most important lode mine in the region, having produced gold to the value of $2,225,000 previous to 1898. The ore contains narrow seams which are very rich in gold. The Homeward Bound-Elizabeth-Mayflower vein averages 1½ meters in width and its decomposed surface ores were worked in an arrastre but heavy masses of sulphides were encountered at depth. The Gold Hill is a well-defined quartz vein in granite varying from a few centimeters to 2 meters in width. Some sulphides, mainly pyrite, are associated with the gold. The Iowa vein, a short distance north of the Gold Hill, is a narrow seam with streaks extremely rich in gold. The Carroll-Driscoll group produced much gold by sluicing disintegrated veins on the Ivanhoe and Capital claims. The primary ore in the upper tunnel consists of veinlets of massive pyrite and a little quartz which carry free gold. The lower tunnel shows several sulphide veins in a wide shear zone containing large quantities of sericitic gouge. The mineralization consisted of gold with tetrahedrite, pyrite, galena, pale-colored sphalerite, and a little barite in quartz. This has been largely shattered and incorporated in a later gouge of sericite containing masses of pyrite showing well-developed crystals. The Kennebec claim yielded rich sluice ground. Numerous veins containing free gold in oxidized limonitic material occur n and along the quartz porphyry dike east of Wolf Creek, including the Golden Chariot, Buena Vista, Big Six, Mineral Hill, and other claims. Near Grimes Pass the Morning Star, Mountain Queen, Pioneer, and other veins yielded oxidized ore consisting of limonite containing native gold with some cerusite, etc. The Barry, Peerless, and King veins at the headwaters of Elk Creek, the Wilson group a little farther north and other veins between Summit Flat and Kempner yield free gold with some sulphides in quartz veins. A specimen of oxidized ore from the Overlook mine contains spongy and mossy pale colored gold in cavities from the removal of sulphides in leached and rusty quartz. Placers occur along Lost River and Bear River near Kempner.

In the Westview (Willow Creek, Pearl, Rock Creek) district placers were worked in the early days, and the Red Warrior mine was located in 1870. This district contains a great number of veins which are fault fissures in granite on either side of which the rock is altered by sericitization and impregnated with pyrite. Along the fissures occur narrow seams of auriferous sulphides—pyrite, black, or dark brown coarse grained sphalerite, arsenopyrite, and galena which are rich in gold. The sparse gangue consists of quartz and calcite. No visible gold can be seen even on panning the richest sulphides. The surface ore is soft and limonitic and contains free gold associated with some cerusite.

BONNER COUNTY

In the Mooyie Yaak district the Buckhorn mines east of Mooyie River and 10 miles north of Kootenai River have produced ore containing native gold associated with galena.

CASSIA COUNTY

The Snake River placers have made a small annual production of fine gold for many years.

CLEARWATER COUNTY

In the Burnt Creek district productive gold placers around Dent are worked by hydraulicking and sluicing.

In the Musselshell Creek (Wieppe) district placer gold has for years been mined from gravels along Lolo Creek. The deposits are not of extraordinary richness. The gold is fine in size but is relatively low grade, being worth only $15 to $17 an ounce.

The Pierce district was the first important placer district discovered in the State. The placers were never remarkably rich but produced well in 1861–62. The production in 1874 was $70,000. There has been desultory placer and quartz mining ever since. The placer production as given for 1908 was $41,255 and for 1909 with 11 mines operating $43,390. Much of the recent work has been done by dredges. The gold averages 0.820 fine (82 per cent Au).

CUSTER COUNTY

In the Loon Creek district the gold ores consist of auriferous chalcopyrite in a quartz-siderite gangue, the principal deposit being the Lost Packer mine. Such ore contains 2 to 3 ounces of gold to the ton.

Some placer deposits of phenomenal richness occurred. A strip of ground 75 feet wide and 1 mile long which was worked in the sixties produced $2,000,000, a single pan of gravel sometimes yielding as high as $300. The gold is coarse, 50 per cent of the product averaging 25 cents or sometimes more to the color while nuggets 25 grams in weight are not uncommon. The average value of the placer gold is $18 an ounce. A sample of placer gold from Hurd's Claim, Loon Creek, mined in 1869, (Cat. No. 55763, U.S.N.M.), consists of small dark-yellow nuggets which are irregular and much flattened.

In the Stanley Basin district some narrow quartz veins in granite carry gold. The chief production, however, is from the placers of Stanley Creek and Joes Gulch, which have yielded about $100,000, the average return for some years varying from $3,000 to $4,500 a year. The gold is coarse—flax to wheat size—and runs 0.717 fine (71.70 per cent Au) bringing $15 an ounce. At the Willis dredge property the gold, which is concentrated on the bedrock, is worth only $13 an ounce. The gold here is associated with native amalgam and cinnabar while elsewhere in the district the rare earth mineral brannerite has been found in the placers.

Gold occurs in the Yankee Fork district with silver in veins of late Tertiary age in volcanic rocks, the gangue being fine-grained quartz and adularia with some opal and chalcedony. The gold is usually very finely divided and is concentrated in narrow dark streaks in the vein, which react for selenium. Some coarser gold is reported from the Morrison vein. The oxidized ore consists of firm quartz heavily stained with iron and manganese oxides. The principal vein mines are the General Custer, Lucky Boy, Charles Dickens, Momson, Golden Sunbeam, McFadden, etc. Placers which have produced gold to the value of $50,000 were discovered on Jordan Creek in the middle seventies. One nugget weighing nearly a kilogram was found near the outcrop of the Morrison vein, others weighed several hundred grams, and many exceeded 25 grams. A specimen lot of gold (Cat. No. 55,475, U.S.N.M.) mined from Bairs (or Blairs?) claim on Yankee Fork consists of fine flattened scales 2 mm. in maximum diameter.

ELMORE COUNTY

In the Atlanta district the gold production from the Atlanta lode has been considerable, some portions of the veins being predominantly gold-bearing, although the district is best known for its phenomenal silver ores.

In the Black Warrior district a nominal production of gold has been obtained from lode mines, chiefly the Double Standard, White Ribbon, Fourth of July, and Magnolia.

In the Highland Valley district near Twin Springs bench gravel deposits are washed with the water from melting snows. The season is only 30 to 35 days annually. The gold is worth $16.02 an ounce.

The Neal district produced gold to the value of $200,000 previous to 1898 from veins in fault fissures and along minor shearing planes in granite. The gangue is quartz and sulphides are common. Spongy skeletal gold is common in the oxidized ore. The gold is worth $15 an ounce.

The Pine Grove district has produced some gold from quartz veins containing auriferous sulphides.

The Rocky Bar district was originally an important placer camp, but in 1895 was reported to be worked only by Chinese. Lode deposits have been mined in the Old Alturas, Idaho, Vishnu, and other mines. The ores consist of quartz containing auriferous sulphides in the primary ore and oxidation products with native gold above. The gold of the veins is worth $14 an ounce. Specimens of primary ore from the Vishnu mine (Cat. Nos. 14761–14762, U.S.N.M.) consist of auriferous sulphides in quartz and of the oxidized ore (Cat. No. 14763, U.S.N.M.) contain gold in rusty quartz. A sample of placer gold (Cat. No. 55469, U. S.N.M.) consisting of very pale colored unworn gold is labeled as from Dry Creek above Loom Creek, Elmore County.

IDAHO COUNTY

The Big Creek district contains large low grade gold deposits which, mineralogically, are very uninteresting. The Goldman and McRae and Moore are the principal mines.

In the Crooks Corral district some placer gold is obtained by hydraulicking bench gravels of the Snake River side of the high divide between Snake and Salmon Rivers, which are here only 12 miles apart. The deposit has been found in places to be very rich, but the work is retarded by the high elevation and scarcity of water. The gold is 0.954 fine (95.40 per cent Au).

In the Dewey (Harpster) district, gold is produced from ores consisting of auriferous chalcopyrite in silicified greenstone schist. Small lots of the ore are very rich. The Dewey is the principal mine.

The Dixie district contains both placers and gold quartz veins. The placer gold is 0.820 fine (82 per cent), having a value of $16.95 an ounce. There is often more or less cinnabar associated in the sand with the placer gold. The Majestic, Dixie-Royal, Diamond Consolidated, and Monadnock are the principal mines. A specimen of ore from the Mallard Creek property of W. Sendke in this district consists of clean white quartz containing sparingly disseminated auriferous galena and light colored sphalerite.

The Elk City district has contained very important placers which were discovered in 1861. Many of the early workings were on so-called "skim" placers where the gold was within less than a meter of the surface. After the first few years the diggings were turned over to the Chinese, but later the interest of white men in them revived. The production about 1900 was varying from $30,000 to $70,000 a year. On American Hill some deep strata of rich ground were found under the old "skim" diggings. The placer gravel is quartzose and large quartz bowlders on the bedrock often contain coarse native gold. Only a moderate number of quartz veins have been found and these have not been continuously productive. Espey's South Fork mine, 8 miles west of Elk City, milled some free gold ore in 1905, while some telluride ore was shipped to Tacoma. The placer output in 1907 was 239 ounces of gold, while in 1908, five lode mines produced gold to the value of $136,000. An interesting specimen of ore from the Black Pine mine consists of white quartz containing native gold with disseminated grains of galena, pyrite, sphalerite, and tetrahedrite. The visible gold occurs as small, irregular grains surrounding the galena. Specimens of ore from the Hercules and Blue Ribbon mines (SI 15–23) are very similar and consist of auriferous galena and pyrite sparsely disseminated in pure white quartz.

The Florence district was discovered in the Autumn of 1861 and has an estimated production, previous to 1896, of $30,000,000. After 1872 the camp was worked mainly by Chinese. Placer deposits occurred on all creeks of the area. All of these were rich, but Baboon Gulch was extraordinarily so. Dredging has been carried on to some extent. The gold is coarse and more or less angular and has a fineness of 0.660–0.705. Much zircon occurs with the gold in the placers. Quartz veins are abundant but have been little exploited. The gold occurs native in coarse comb quartz, and sulphides are almost entirely absent. The vein gold is 0.650 fine. The principal veins are the Hi Yu, Banner, Gold Bug, Blossom, Ozark, Waverly, and Poorman. A specimen (Cat. No. 55809, U.S.N.M.) of placer gold which is probably from this district, and is labeled as having been mined from Wilson's claim, Idaho County, in 1880, is irregular, slightly worn, and contains quartz.

Newsome district, 6 miles west of Elk City, contains placer gold in deep gravel banks. The Moose Creek placer, which is the largest operator, has 26 miles of ditches. The gold, which is both coarse and fine, varies in value from $16 to $19.20. Several gold-quartz veins are worked. Seven placers and 2 deep mines produced $10,826 in 1908.

The Oro Grande district is 12 miles south of Elk City. The veins are mostly large and low grade, although rich native gold ore was found on the Higan claims in 1905.

The Robbins of Buffalo Hump deposits consist of a network of quartz seams along joints in granite. The gold occurs in white quartz with scattered masses of pyrite, galena, chalcopyrite, and tetrahedrite. The Jumbo mine in 1902 was producing 2,000 tons of ore a month. The district contains some placers.

The Salmon River placers or Simpson district contain gold bearing gravels which are worked by tunneling. One lode mine—the McKinley Gold Mining Co.—is operating. The placer gold of the district averages 0.836 fine, being worth $17.28 an ounce. The production was $4,627 in 1908 and $3,152 in 1909.

The Thunder Mountain district exhibits several deposits of unusual character, the chief properties being the Sunnyside and the Dewey. In the Sunnyside the gold occurs in a mineralized rhyolite breccia containing a considerable amount of tuff, the metal being mixed with clay along fractures and joints. The mineralized flow is from 15 to 30 feet thick and is underlain by rhyolite and overlain by volcanic mud, both of which are barren. The breccia averages $4 to $11, although some lots run $35. The gold is alloyed with silver in approximately the proportions of electrum as placer gold from the outcrop is worth only $11 an ounce and the ore assays 2 to 3 ounces of silver a ton. Geological conditions are similar at the Dewey mine, where the gold occurs in seams in a rhyolite tuff. The rock between seams is barren. The gold is sometimes found associated with pyrite and nodules of pyrite may contain leaf gold in the center. Some very rich pockets of ore were extracted near the surface. The tuff contains charred logs of wood up to 2 feet in diameter and 60 feet long, which are frequently impregnated with native gold. The gold is much more abundant near the surface and is in all probability due to secondary enrichment of low grade rock.[14] A sample of the gold concentrated by panning from the volcanic breccia (Cat. No. 74439, U.S.N.M., gift of Victor C. Heikes, 1902) consists of fine, mossy grains which, under a lens, are seen to be made up of dendritic or arborescent groups of crystals similar to the "wire" copper and "wire" silver of the Coeur d'Alene district.

The Warren district recorded a production of $15,000,000 in gold previous to 1896, although after 1870 the placers were worked chiefly by Chinese. Vein mining began in 1866 after the richest placers were depleted and the lode mines had produced $125,000 up to 1871. The placers were mostly comparatively shallow and are now largely exhausted except certain deeper gravels along Meadow

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[14] J. B. Umpleby and D. C. Livingston. Reconnaissance of South Central Idaho, Idaho Bureau Mines and Geol. Bull. 3, pp. 5–6, 1920.

Creek. The black sand contains much garnet, also some monazite. The gold occurs in streaks in the gravels and is fairly coarse. It has a value of $15 an ounce, or is 0.710 to 0.720 fine. The progressive change in purity away from the source has been mentioned on page 55. The lode deposits had produced $2,000,000 up to 1896. The veins consist of white quartz carrying about 2½ per cent of sulphides, mainly sphalerite, galena, pyrite, and arsenopyrite, together with native gold, native silver, tetrahedrite tellurides, argentite, and scheelite. The principal veins are the Little Giant, Rescue, Goodenough, Charity, and Knott. The Goodenough vein consists of from 2 to 20 cm. of solid quartz with well-defined walls. The ore is high grade, showing native gold and sulphides including zinc blende, pyrite, ruby silver, and probably tetrahedrite and arsenopyrite. The sphalerite is rich in gold while the pyrite is poor.[15] The Rescue vein forms a belt of crushed granite 15 to 50 cm. in width, schistose in places and inclosing small veinlets of quartz containing foils of native gold. Scheelite accompanies gold in the Charity vein. In 1916 the production from four lode mines was $12,441 in gold.

KOOTENAI COUNTY

The Camas Cove or Tyson district had a production previous to 1905 of $500,000, entirely in placer gold.

LATAH COUNTY

Potlatch of Gold Creek district contains some gold placers. The production in 1905, for example, was 225 ounces of gold.

In the Moscow district some gold is produced from intermittent placer operations.

LEMHI COUNTY

In the Blackbird district gold occurs as low grade replacements of Algonkian quartzites and schists (Blackbird Copper-Gold Mining Co.) and as oxidized quartz veins containing native gold in quartz much stained by iron and manganese oxides (Musgrove group).

In the Carmen Creek district the Oro Cache, which is the principal deposit, is a gold-quartz vein following a fault in quartzite. The ore is mostly oxidized and is much stained by iron and manganese oxides. The primary ore, where encountered, contains some pyrite, chalcopyrite, galena, and sphalerite. The Carmen Creek mine is a replacement deposit consisting of quartz lenses containing chalcopyrite, pyrite, and bornite. Much of the vein is oxidized and native gold occurs with cerargyrite in cavities and along fractures in the secondary ore. A specimen from Umpleby's collection shows native gold as pale yellow flakes and hackly grains associated with bornite in quartz.

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[15] Waldemar Lindgren, U. S. Geol. Survey, 20th Ann. Rep., pt. 3, pp. 247-249, 1900.

The Eldorado (Geertson) district contains the Eldorado and Ranger as the principal veins. These are brecciated zones with lenses of quartz containing native gold with pyrite, chalcopyrite, and rarely a little galena with their oxidation products. The placer of Bohannon Bar was early worked by Chinese. The first 18 inches above bedrock is the most productive. The gold, which occurs as coarse flakes, fine grains, and small nuggets, is worth $18.60 an ounce. The total production is about $350,000, the annual production around 1910 being $15,000 to $20,000.

In the Eureka district the U. P. & Burlington, Queen of the Hills, and Tenday mines are coarse quartz veins in granite. The primary ore contains sulphides, chiefly pyrite with some chalcopyrite and rare galena in isolated grains, irregular bunches, and in some places in parallel bands. The gold is associated with the pyrite. The workings are entirely in the oxidized zone and primary ore is seldom found. The total production of the district is only about $150,000.

The Forney or Gravel Range district contains gold in veins of crustified quartz in rhyolite. The gold is very finely divided and distributed along dark bands in the ore which react for selenium. The original quartz is hard and flinty but it weathers to a sugary mass. The Monument, which is the principal mine, has a strong vein, while the Rabbitfoot has encountered only stringers of rich ore. The total production of the district is about $100,000. A few small placers have been worked by Chinamen.

The McDevitt district contains only one important gold mine, which is known as the Copper Queen and has a production of $100,000. The gangue is quartz with a little calcite, and the vein varies from a few centimeters to 3 meters in width. The gold occurs free in small grains associated with bornite and a little chalcopyrite and chalcocite.

The Gibbonsville district is credited with a gold production of $2,000,000, half of which is from the A. D. & M. mine. Other important mines are the Clara Morris and Twin Brothers, while a number of lesser lodes have been opened. The primary ore consists of auriferous pyritic quartz, 60 per cent of the gold being inclosed in pyrite. The oxidized ore is heavily stained by iron and manganese oxides.

The Indian Creek or Ulysses district has produced gold to the value of $600,000, mainly from the Ulysses and Kittie Burton mines. The ore bodies are tabular, flat lying quartz veins which are largely oxidized. Some sulphides occur locally.

The Kirtley Creek district contains the White Horse mine as its principal lode-gold deposit. The vein is irregular, with a filling of quartz containing native gold in small grains associated with the products formed by oxidation of primary pyrite, chalcopyrite, and galena. Gold-bearing placers occur along Kirtley Creek in the recent stream gravels. At the upper end of the deposit the gold is confined to the bedrock but toward the lower end it is scattered throughout the bottom 2 or 3 meters. It grades from the size of shot above to small flakes below, nuggets up to 75 cents in value being found only rarely.

The Leesburg district is credited with a placer production of $5,000,000 and a lode production of $225,000. The placer deposits in the Leesburg Basin cover 1,000 acres. The gold, most of which is confined to the first 40 centimeters above bedrock, is in coarse and fine grains with rare nuggets worth $15 to $20. The district, which was discovered in 1866, saw its greatest production in the first four years of its history. The population at that time was 7,000 and freight had to be brought by team from Fort Benton, Mont.

The Mackinaw district contains the Moose Creek placers, which cover 200 acres and have produced placer gold to the value of about $1,000,000. The gold, which is worth $19 an ounce, occurs in cracks in the bedrock, or up to 40 centimeters above bedrock, beneath the gravels 3 to 5 meters deep. The Beaver Creek placers have yielded $100,000. Lode-gold deposits of various types occur: (*a*) Quartz veins accompanied by stockworks in granite, including the Italian mine and adjacent properties, with a production of $175,000; the gold is accompanied by pyrite, sphalerite, and galena. (*b*) Replacement auriferous pyrite-quartz lodes along faults between contact metamorphic sediments and granite; to this class belong the Gold Dust, Gold Reef, and Gold Flint mines. (*c*) Replacement along shear zones in schist by pyritic quartz accompanied by development of epidote and magnetite as in the Mayflower and Copper King veins. (*d*) Small auriferous quartz lenses in schist and in granite, including the Shoo Fly vein; these lenses are the source of the Moose Creek placer gold. (*e*) Coarse bluish quartz containing gold with auriferous chalcopyrite and sphalerite at the contact of a biotite-monzonite dike.

The Mineral Hill or Shoup district has a recorded gold production of $750,000, all of which is from lodes which are coarse quartz veins containing sulphides irregularly distributed. The sulphides, which include pyrite with less galena and sphalerite, are auriferous. Oxidation extends only to shallow depths. The principal mines are chiefly the Monotech, which has produced $175,000; the Grunter, which produced $50,000 from ores near the surface; the Kentuck, Clipper Bullion, and Big Lead. Some small streaks of the ore are very rich.

The Parker Mountain district is similar to the Gravel Range district in that its veins are of late Tertiary age and are inclosed in Tertiary lavas. The gangue is quartz which contains adularia, and the gold occurs finely disseminated in dark selenium-bearing streaks. The production of the district has been small.

The Pratt Creek district contains only a single noteworthy gold mine, the Goldstone. The ore consists of quartz in which the gold occurs either in auriferous chalcopyrite or in its alteration products.

The Texas Creek or Gilmore district is predominantly a lead-silver district. One gold vein is known, however, the Martha vein, which is inclosed in limestone. The ore is largely oxidized and contains fine leaf and flake gold imbedded in limonite. The vein is the property of the Allie Mining Co., and the specimens have been distributed somewhat, in collections, the locality being given as the Allie mine.

The Yellowjacket district has a lode production of $450,000. The ores are fissure fillings and replacements. The gangue is coarse white quartz. Pyrite carries most of the gold, although in the Columbia mine the gold is contained in chalcopyrite. Some small placers have been worked.

ONEIDA COUNTY

The Cariboo mine in the Cariboo district contains massive auriferous chalcopyrite and arsenopyrite, or auriferous malachite and chrysocolla, or spongy limonite formed by oxidation.[16]

OWYHEE COUNTY

The Carson (War Eagle, Silver City, Florida Mountain) district contains a large number of rich veins which have made a very great production, the total production of the county, including the De Lamar and Mammoth districts, from earliest discoveries to the end of 1898 in precious metals amounting to a value of $27,963,652. The ratio of value between gold and silver in the production previous to 1880 is not known. From 1880 to 1898 the production was gold $6,477,065 and silver $8,080,065. The silver is generally predominant in value as well as in weight but the ratio between the two metals varies abruptly from year to year and from mine to mine. Native gold is of universal occurrence associated with native silver and various sulphides and sulpho salts of silver, but is most abundant in oxidized ore. This gold is normally very pale yellow in color, representing the high-silver alloy known as electrum. The veins are of post-Miocene age in granite, rhyolite, or basalt. They are normal fissure veins in which the ore mostly occurs as a typical filling of cavities, although some low-grade ores in rhyolite are formed by replacement of country rock. The principal ore minerals are finely divided argentite and chalcopyrite, the latter being highly auriferous. The gangue consists of quartz and valencianite (orthoclase). The ratio of gold to silver varies even in the same mine, some very rich bodies of gold ore being found in predominantly silver mines and vice versa. The principal lode mines, of which there are very many, are the Oro Fino system, including the Oro Fino, Ida Elmore, Golden Chariot, Minnesota, Mahogany, and Cumberland mines; the Poorman system, including the Poorman, Silver Cord, and others; the Empire system and the Florida Mountain system, including the Black Jack, Trade Dollar, Mammoth, Tip Top, Ontario, and others. A specimen of high-grade gold ore from the stope between the 150 and 300 foot levels of the Black Jack mine, collected by E. L. Jones, jr., contains abundant pale yellow grains of mossy gold in cavities in quartz from which the sulphides have been removed by oxidation. Specimens in the gold ore collections of the National Museum from this district include specimens from the Ida Elmore, from the Mahogany mine, showing gold with finely disseminated argentite and native silver (Cat. Nos. 14774–14776, U.S.N.M.), from the South Chariot mine (Cat. No. 14,777, U.S.N.M.), and the Red Jacket mine (Cat. Nos. 14781–14782, U.S.N.M.). A specimen from the Minnesota mine contains gold with finely disseminated argentite in narrow banded quartz-adularia veins (Cat. Nos. 4477, 14783, 14784, U.S.N.M.). A specimen from the Carson mine shows gold in limonite in the center of coarse comb quartz veins (Cat. No. 4478, U.S.N.M.). A specimen of unoxidized ore from the Ida Elmore mine contains gold in rather large grains in bluish quartz with disseminated sphalerite and galena (Cat. No. 65675, U.S.N.M.). A specimen from the same mine (Cat. No. 55786, U.S.N.M.) is a brilliant crystalline sponge of pale yellow gold. Placers, although now thoroughly exhausted, were worked extensively in this district in its earlier years. Jordan Creek and especially Blue Creek were extensively washed. Rich pay was also found in the gulches leading eastward from War Eagle Mountain. The richest placers led right up to the outcrops of the veins. Placer washing on a small scale continued for many years, chiefly by Chinese miners. One of their operations produced $20,000 in 1870. The placer gold is very pale in color and is worth only $10 an ounce. It is little worn. Two nuggets from Reynolds Creek, Booneville (Cat. No. 55777, U.S.N.M.), are well rounded and contain three-fourths quartz and one-fourth gold by volume.

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[16] Specimens Cat. No. 51869–51870, U.S.N.M.

The De Lamar district is a continuation of the Silver City district; the veins are filled fissures in rhyolite, accompanied by alteration of the country rock. The De Lamar, the principal mine, has produced about $6,000,000 in gold and silver. The ore is platy, laminated, pseudomorphous quartz (q. v.) containing only three-fourths of 1 per cent of metallic minerals. The values are chiefly in gold, although certain stopes produced rich silver ore. The greatest production was from 1891–1897. The other mines in the district, including the Henrietta, are principally silver producers.

The Flint district is principally noted as a silver district, although the ores contain a little gold. The mines have been operated intermittently since 1865. The Rising Star, Leviathan, and Perseverance are the principal claims.

The Mammoth district contains large quartz veins containing auriferous pyrite, in granite. The production has been small.

Placers on Snake River in Owyhee County are worked in a small way, the output being 38.35 ounces of gold in 1907 and the product for 1908 being valued at $870.

SHOSHONE COUNTY

The Coeur d'Alene district, although later better known for its lead-silver ores, began as a gold mining district and produced gold to the value of $4,710,489 previous to 1906. Native gold occurs in quartz veins in the Prichard slate (Algonkian) and in placer deposits of local derivation, particularly in that part of the district tributary to the north fork of the Coeur d'Alene River and adjacent to the town of Murray. Much of the quartz formerly mined was very rich and contained coarse free gold. The veins are narrow and the gold is erratically distributed or "pockety." They are commonly very flat lying "blanket" veins following bedding planes in the black slates. The principal gangue is clean white quartz which in some veins, notably the Golden Chest and Golden Winnie (Friday), contains masses of pale brown scheelite. The sulphides commonly accompanying the gold are auriferous pyrite, chalcopyrite, galena, and sphalerite. Although some galena is found in the gold veins, these do not grade into silver-lead veins. The two types are distinct, gold being practically absent from the deposits worked for lead and silver. The principal mines are the Golden Chest and the Ophir Mountain mines, including the Yosemite, Daddy, Mother Lode, Treasure Box, and Occident, all on Prichard Creek east of Murray. The Yosemite, which was discovered in 1893, produced $500,000. The Buckeye Boy mine in Dream Gulch produced $25,000 from a pocket of rich ore in 1885, some of the ore containing 550 ounces of gold a ton, and showing coarse native gold. The Crown Point mine in Trail Gulch has also yielded valuable ore.

Numerous other auriferous veins have been opened, one of the most recently discovered, the Pilot property of John Doctor having produced rich ore containing native gold and gold tellurides. Gold-bearing veins have also been worked to some extent east of Kellogg, on Elk Creek (Gold Bug), Gold Run (New Jersey mine), and Big Creek. These ores are mostly low grade on the average and the mines are now idle. A unique occurrence of gold in this district is in the Stanley antimony mine at Burke where thin, frost-like films of native gold occur coating cracks and rifts in coarse stibnite.

The placers lie mainly on Prichard and Beaver Creeks or on streams tributary to them. The placers occur as bench gravels perched high on the hillsides and the alluvial deposits of the present stream bed. The latter were richest and were first worked mainly by panning and sluicing. Some of them were very rich, among the famous being the Widow and the Gillett, which in 1885 produced $25,000 from a single acre. Rich placers occurred also on Trail Creek, the Myrtle claim especially being noted for large nuggets. Many tributary streams have been worked. The old wash deposits (bench gravels) which have been worked by hydraulicking are not so rich as the recent gravels. The placer gold of the younger gravels is coarse, nuggets up to 40 ounces in weight having been found. These are usually somewhat rough and hackly and many of them contain some of the quartz in which they were originally embedded. The gold ranges in value from $15 to $18 an ounce. The total production of placer gold in 1905 amounted to about $50,000.

The St. Joe district has not made any noteworthy production of gold from lode mines. The St. Joe placer deposit is a gravel-covered flat at the head of the middle fork of the St. Joe River. Although discovered in 1870 this deposit has been worked only on the edges, the gravels being deep and so situated that drainage of them is not feasible. No great production has been made. Free gold occurs in quartz seams cutting the bedrock.

WASHINGTON AND ADAMS COUNTIES

The Meadows district is noted as containing the Rock Flat gold placer mine from which some gold has been mined. No adequate description of this deposit is available but some reports suggest that it may in part be a deeply weathered igneous intrusive rather than a gravel deposit. It is interesting, mineralogically, as the source of much corundum and a few diamonds.

The Mineral district may be considered an extension of the Blue Mountain district of Oregon. The Connor Creek, which is the principal mine, has produced about $2,000,000 in gold. The gold is native and is very coarse, associated with pyrite and argentite. It is worth $19 to $20 an ounce.

In the Seven Devils district some gold occurs in the contact metamorphic copper deposits. A specimen in the National Museum shows leaves and angular masses of gold in cavities in malachite. A little placer gold occurs below the Peacock claim.

ELECTRUM

Alloy intermediate between gold and silver $Au+Ag$ Isomeric.

Native gold is exceedingly variable in its content of silver as has been indicated in the value per ounce or fineness given for the gold from the various districts. The pale yellow alloy containing approximately equal parts by weight of gold and silver is given the varietal name electrum. Many of the lode mines of Idaho have produced gold high enough in silver to be properly designated by this name. A few examples may be mentioned.

ELMORE COUNTY

Vein gold from the Rocky Bar district contains 70 per cent gold and 30 per cent silver, computed from the assay value recorded.

IDAHO COUNTY

Placer gold from the Florence district is only 0.660 to 0.705 fine. Placer gold from the outcrops of the Thunder Mountain deposits contains 55 per cent of gold and 45 per cent of silver.

OWYHEE COUNTY

Practically all of the vein gold of the Silver City district is electrum. Placer gold from this district is very pale in color and contains about half gold and half silver.

MALDONITE

BISMUTH GOLD

Gold bismuthide, $Au\ Bi_2$.

CUSTER COUNTY

Maldonite, the rare combination of bismuth and gold, has been reported to occur in the Empire claims of the Idaho-Montgomery Mining Co. in Washington Basin.[17] This report has not been authenticated.

GOLD AMALGAM

Natural alloy of mercury and gold, $Au + Hg$.

CUSTER COUNTY

A natural amalgam containing gold as well as silver occurring in the auriferous gravels of the Willis dredge property in Stanley Basin is described below under the heading Amalgam.

SILVER (14)

Silver, Ag. Isometric

Although nowhere very abundant, native silver is of rather common occurrence in the oxidized portions of silver-bearing veins in Idaho. The principal occurrences are here listed.

BLAINE COUNTY

In Blaine County silver occurred in several mines of the Wood River district, especially the Bullion. A specimen labeled Neptune mine, Blaine County, in the National Museum (Cat. No. 56536, U.S.N.M.) shows thin folia and grains of native silver with mossy grains of argentite disseminated through altered granite.

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[17] Editorial. Eng. Mining Journ., vol. 83, p. 23, 1907.

BOISE COUNTY

Silver in native form occurred rather abundantly in the richer silver ores of the Poorman mine, Banner district, where it was associated with pyrargyrite, cerargyrite, polybasite, argentiferous galena, and gold.

BONNER COUNTY

Native silver occurs in small amount in the oxidized portions of the Weber and other veins near Lakeview on Lake Pend Oreille.

CUSTER COUNTY

Native silver occurs sparingly in Custer County as twisted wire-like filaments in cavities in the late Tertiary oxidized ores. In the Yankee Fork district wire silver, together with argentite and cerargyrite, is mixed with manganese oxides. In the Charles Dickens mine it occurs with gold. In the Golden Sunbeam mine where electrum is present in the primary ore, native silver occurs with pure gold in the oxidized zones.[18] In the Bayhorse district silver is found in leaf and wire forms in the Skylark and River View mines.

ELMORE COUNTY

In Elmore County silver occurred formerly in rich ores of the Atlanta district. Lessees on the Old Monarch ground on the Atlanta lode encountered a 6 centimeter streak of rusty quartz containing abundant native silver at the surface, with a streak of similar width containing ruby silver.

IDAHO COUNTY

In Idaho County native silver has been found in the Little Giant vein, Warren district, with tellurides, argentite, and bromides of silver.[19]

LEMHI COUNTY

Although rare, native silver has been found in the Texas district and also in the Gold Flint property in the Mackinaw district.

OWYHEE COUNTY

Native silver occurred rather sparingly in the Trade Dollar, Poorman, and other mines of the Silver City district.

SHOSHONE COUNTY

Native silver constantly accompanies cerusite and other secondary minerals in the oxidized portions of the silver-lead veins. It commonly appears in dendritic moss-like aggregates of distorted crystals strung into wires or forming spongy masses.

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[18] J. B. Umpleby, U. S. Geol. Survey Bull. 539, p. 53, 1913.

[19] Waldemar Lindgren, U. S. Geol. Survey, 20th Ann. Rept., pt. 3, p. 246, 1900.

It occurs in open cavities in the cerusite ores, sometimes in considerable amount, notably in the Mammoth, Morning, You Like, Hercules, Poorman, Tyler, Bunker Hill, Caledonia, Sierra Nevada, and other veins. In the Tyler mine coarse aggregates of crystalline wires were attached loosely to cerusite crystals or imbedded in spongy limonite. One small cavity found by the writer in lease workings in 1912 yielded 9 ounces of such wire silver and a similar cavity in the Barney stope on this vein was said to have yielded enough loose silver to fill a nail keg. Delicate frost-like silver was common in the Sierra Nevada mine. In the Bunker Hill ores silver was not so common, but it occurred near the surface in the Blacksmith stope in white cerusite. The Caledonia mine probably supplied as much or more native silver than any other mine in the district. Here it occurred in cerusite and limonite and also as strings and wires in large amount in brecciated and leached white quartzite. Sometimes such quartzite yielded slabs of silver 3 millimeters in thickness and several centimeters in diameter. Thin foil also occurred in narrow cracks in the ores. In soft clayey gouge the native silver was intimately mixed with native copper and coarse dendritic wires of copper occasionally had a thin natural outer plating of silver.[20] In the Hercules mine native silver was common in the oxidized ores as the usual fine dendritic mossy aggregates and also in places as coarse wires. Some of the mossy silver was deposited on anglesite crystals.[21] In the Yankee Boy mine on Big Creek native silver has been found as irregular hackly masses coated with manganese oxide. In the Snowstorm mine small grains of native silver occurred disseminated in white quartzite with small amounts of malachite.

WASHINGTON AND ADAMS COUNTIES

Native silver is reported to occur with horn silver, argentite, and cerusite in veins of the Heath district.

COPPER (15)

Copper, Cu. Isometric.

ADAMS COUNTY

Native copper occurs sparingly in the oxidized ores of the contact metamorphic copper deposits particularly in the South Peacock mine.

BOISE COUNTY

Copper has been noted in small amount in oxidized gold ore from the Coon Dog mine, Summit Flat district.

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[20] Earl V. Shannon. Economic Geology, vol. 8, p. 565, 1913.

[21] Earl V. Shannon. Proc. U. S. National Museum, vol. 58, p. 441, 1920.

CUSTER COUNTY

In the Alder Creek district thin films of copper occur along fractures on the 300-foot level of the Empire mine and also as small specks in nodules of cuprite.[22]

LATAH COUNTY

Native copper occurs in the oxidized ore of the Mizpah mine, Hoodoo district, along with malachite, copper pitch ore, and cuprite.

LEMHI COUNTY

Copper appeared occasionally in thin films along fractures in ores of the Indian Creek district and also in the Beaver Creek district.[23]

SHOSHONE COUNTY

Copper occurred rarely and in small amount in ores of the Snowstorm mine at Larsen. Fine crystallized specimens have been obtained from the Iron Mask mine. In the Caledonia mine copper is rather common in the oxidized ore in dendritic moss-like forms entirely like those characteristic of the native silver. These occur implanted upon cerusite or embedded in spongy limonite. In the Boyle stope small nugget-like masses of native copper were intimately mixed with similar masses of native silver.[24] Crystalline wires of native copper occurring on the 700-foot level of this mine bore a thin outer plate of native silver. Native copper formerly occurred in similar wire-like forms at the Tyler mine.[25]

AMALGAM (17)

Silver amalgam sometimes with gold (Ag, Au, Hg). Isometric.

CUSTER COUNTY

Native amalgam has been reported from the gold-bearing gravels worked by the Willis dredge across the divide from Joe's Gulch in the Stanley Basin district. The amalgam is associated with cinnabar, the latter mineral becoming more abundant as the dredge is moved upstream.[26] A sample of pan concentrate received from H. C. Willis, manager of the dredge, consists largely of brannerite or a similar radioactive black mineral associated with which is considerable cinnabar and a few grains of amalgam. The largest grain of the latter, when selected from the concentrate and heated in a closed tube, gave a sublimate of mercury. The remaining metallic mass was malleable and after being flattened with a hammer was heated with nitric acid. The residue was yellow gold and the nitric acid gave a copious precipitate of silver chloride with hydrochloric acid. The amalgam apparently contains more gold than silver. It seems probable, from a study of this sample, that the gold and mercury have been derived from different sources and that amalgamation has taken place in the gravels. That the mercury is native and not lost from placer mining operations is indicated by the abundance of cinnabar.

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[22] J. B. Umpleby. U. S. Geol. Survey, Prof. Paper 97, p. 52, 1917.

[23] J. B. Umpleby. U. S. Geol. Survey, Bull. 528, p. 76, 1913.

[24] Earl V. Shannon, Econ. Geol., vol. 8, p. 565, 1913.

[25] W. Howard McBride. Oral communication.

[26] J. B. Umpleby and D. C. Livingston. Idaho State Bur. Mines and Geol., Bull. 3, p. 16, 1920.

LEAD (18)

Lead, Pb. Isometric.

Native lead is a very rare mineral which has been found in two widely separated districts in Idaho.

BLAINE COUNTY

In Blaine County, in the Wood River district, native lead has been found with minium at the Jay Gould mine in the midst of masses of galena. The metallic lead is in the form of small rounded grains from 3 to 5 mm. in diameter and sometimes in irregularly reniform bunches weighing 25 grams or more, usually coated with minium.[27] Other specimens show native lead without any galena, running through a mass of quartz which is stained red by minium. The quartz is somewhat cracked and the pieces are held in place by filaments of lead. A white coating of lead carbonate appears in a few small cavities. The lead is argentiferous.[28]

A specimen from near Hailey (Cat. No. 48832, U.S.N.M.) received from Baldwin Moore in 1890 consists of native lead in masses and filaments with galena in compact anglesite of a gray color.

In 1923 C. P. Ross, of the United States Geological Survey, obtained a small specimen of native lead from the Arizona mine a little north of the Bullion.

SHOSHONE COUNTY

In the Coeur d'Alene district, in Shoshone County, a single specimen from the upper workings of the Mammoth mine at Mace showed native lead as two stout wires projecting from a mass of granular galena.[29] The material occurring in many mines and especially in certain stopes of the Bunker Hill mine, which is called "pure lead" by the miners, is a very finely compacted form of galena which is sectile, soft, and shows no granular structure.

PLATINUM (20)

Platinum alloyed with iron and other metals. Pt., Fe. Isometric.

Platinum in very small amount has been reported to occur in a number of counties in Idaho, but definite data amplifying these several reports have not been available,[30] except in the case of the Minidoka occurrence as follows:

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[27] W. P. Blake. Amer. Jour. Sci., ser. 3, vol. 25, p. 161, 1883.

[28] W. F. Hillebrand. U. S. Geol. Survey, Bull. 20, p. 99, 1885.

[29] W. Howard McBride. Oral communication, 1911.

MINIDOKA COUNTY

David T. Day investigated a number of black sands from Idaho with especial reference to their platinum content, and reported that several of them contained platinum, the richest, a Snake River black sand from near Minidoka, assaying 0.018 ounces of platinum to the ton.[31] Bell carefully investigated this occurrence and found that the residue yielding this result represented a concentration from the gravels of several thousand to one. The platinum occurs in the fine sands along Snake River but is too thinly scattered to be of commercial value. It is associated with the gold in the gravels but can not be detected by panning, although invariably encountered in cleaning amalgam. In the operation of the Sweetzer-Burroughs dredge near Minidoka platinum was always observed at clean-up time as ashy gray particles which floated when the amalgam was thinned with mercury for the purpose of separating foreign materials from the gold. One-fourth ounce of platinum obtained in this manner is in the possession of Louis Sweetzer of Rupert, Idaho. The heavy minerals of the concentrate form about one-fourth to one-third of 1 per cent of the gravel and after the free gold is amalgamated out the residue assays less than $5 a ton in gold. After amalgamation one sample of black sand assayed $3 a ton in gold, with only a trace of platinum.[32]

IRON (25)

Native metallic iron. Fe. Isometric.

LEMHI COUNTY

No occurrence of terrestrial iron is known in the State. For the sake of completeness it seems desirable to mention the metallic iron of a small meteorite which was found in 1895 in placer washings on Hayden Creek in Lemhi County. This object was kidney shaped and weighed about 275 grams. The metal showed coarse octahedral structure on etched surfaces and was rich in ferrous chloride. So far as known no analysis has ever been made.[33]

REALGAR (26)

Arsenic monosulphide, As S. Monoclinic.

CASSIA COUNTY

Dr. E. S. Larsen found that the pulverulent red mercurial material of the ore from the Black Pine cinnabar prospects in Cassia County contained considerable arsenic and writes that it is probably a mixture of cinnabar and realgar. This is further shown by its oxidation near the surface, which gives rise to considerable amounts of scorodite.[33a]

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[30] F. C. Schrader. U. S. Geol. Survey, Bull. 624, p. 120, 1917.

[31] David T. Day and R. H. Richards. U. S. Geol. Survey. Mineral Resources U. S. for 1905, p. 1195.

[32] Robert N. Bell. Ann. Rept. State Inspector of Mines for 1906, p. 115. Boise.

[33] W. E. Hidden. Amer. Journ. Sci., vol. 9, p. 367, 1900.

STIBNITE (28)

ANTIMONY GLANCE

Antimony sulphide, Sb_2S_3. Orthorhombic.

This mineral is the principal ore of the metal antimony. A number of deposits are known in Idaho and although under normal conditions these can not be worked in competition with imported metal, considerable amounts of antimony have at times past been produced from them. Well crystallized stibnite specimens have not been seen, although large masses of pure stibnite make good cabinet material. The principal occurrences are as follows:

BLAINE COUNTY

Stibnite is reported to occur in considerable quantities in the Sawtooth Range, but no adequate description of the deposits is available. The so-called antimony or stibnite of the Minnie Moore, Independence, North Star, and other lead mines of the Hailey Quadrangle, Wood River (Mineral Hill) district has all been found upon examination to be boulangerite.

BOISE COUNTY

In rich ores of the Boise Basin region at the Mountain Chief, Belshazzar, Gold Hill, and other mines, stibnite has long been reported to occur as an associate of gold. This supposed stibnite has proven, upon examination, to be either bismuth sulphide or a bismuth-lead sulphide.

BONNER COUNTY

Stibnite occurs in massive form intergrown with other sulphides in silver ore in the Weber mine south of Lake Pend d'Oreille sometimes in fair amount and it also occurs as the ore of an antimony prospect near Smith's ranch on Chloride Creek 4 miles south of the town of Lakeview.[34]

CUSTER COUNTY

Antimony glance has been reported from Custer County, but nothing could be learned regarding the deposits.

IDAHO COUNTY

In Deadwood Gulch just off the road between Oro Grande and Elk City, stibnite occurs as a replacement in granite adjacent to a quartz vein.[35]

[33a] E. S. Larsen. Univ. of Idaho Sch. of Mines Bull. 2, pp. 65–67, 1920.

[34] Edward Sampson. U. S. Geol. Survey. Oral communication.

[35] D. C. Livingston. U. of Idaho Sch. of Mines Bull. 2, 1919.

OWYHEE COUNTY

Stibnite occurs abundantly in the Flint district in silver bearing quartz veins. In the Rising Star mine needles and blades of this mineral up to 5 cm. in length occurred with silver minerals in coarse white comb quartz (Cat. No. 1287, U.S.N.M.). In the Flint mine it is abundant as granular masses in quartz in the upper levels, especially the third level, and decreases in amount with depth. In the Mammoth district stibnite occurs in seams of bluish quartz on the hanging wall of a large gold-silver-bearing quartz vein in the Sunset Claim on Boulder Creek 1½ miles above Duvall Ranch. In the Shore Claims on East Creek stibnite in masses up to 30 cm. in width is abundant in white quartz.

SHOSHONE COUNTY

Stibnite has been mined from a number of deposits in the Coeur d'Alene district in Shoshone County and two small plants were built years ago to reduce the ore or convert it to oxide. The oldest mine is that known as the Coeur d'Alene Antimony, immediately beside the stream near the mouth of Pine Creek. The vein lies in a strongly crushed zone along a flat fissure, possibly a thrust fault, in typical blue slaty argillites and shales of the Prichard formation. There is no marked dissimilarity in the wall rocks on the two sides of the fissure. In one exposure the footwall of the fissure contained a large number of seams of translucent quartz 1 to 2 cm. wide which contain some pyrite but no stibnite, and cut off by the quartz of the stibnite vein. These do not occur in the hanging wall at this point. The ore-bearing vein lies in the center of the crushed zone and has an average width of half a meter, but in places reaches 2 meters. The filling consists of semitranslucent to opaque white quartz carrying varying proportions of stibnite. Even where there is no visible stibnite the quartz has a cloudy appearance and gives a reaction for antimony. Minute light colored grains of sphalerite occur disseminated in the quartz but no galena is known in the vein. The vein quartz is everywhere checked by close-spaced fractures which are less noticeable in the richer ore. There are some indications that the stibnite may be later and a replacement of the quartz. The stibnite is said to be entirely confined to the quartz and never occurs in the walls of the vein or in the gouge of the fissure.

The mill concentrates carry some gold and the statement was made by the manager of the mine that the gold content ran higher when much footwall rock was milled. The footwall contains numerous isolated crystals, streaks and bunches of crystalline yellow pyrite similar to that occurring throughout the Prichard rocks in the Pine Creek area. The pyrite stringers are cut by the small quartz seams which, in turn, are older than the stibnite vein. Since the above statement implied that the pyrite was auriferous, several gold assays were made by W. McM. Huff with the following results: Pyrite in slate from footwall, 50 per cent pyrite, $0.41 a ton; quartz of spur veins from footwall, gold, none; quartz from main vein containing microscopic needles of stibnite and rare grains of sphalerite, $1.66 gold a ton. These results show that the idea that the gold is derived from the pyrite of the footwall is erroneous. The gold, like the antimony, is practically confined to the quartz of the main vein. At the exposure of the vein on the surface it consists of crushed quartz and wall rock cemented into a breccia by limonite and dirty white oxides of antimony. Apparently the vein was as rich in antimony at the present surface as at any point exposed below. The antimony-bearing portion appears to form a lens lying in the fissure and the vein can be traced some distance beyond the workings. The ore is all confined to the one vein, although there has been no crosscutting done in search of other veins. No arsenopyrite or other arsenic mineral was seen. The general trend of the vein is N. 25° E. and the dip is from 35° to 50° NW.[36]

A number of other veins carrying notable amounts of stibnite have been prospected on Pine Creek in recent years. None of these except a small lens of stibnite in the Sherman mine has been seen by the writer. Several carloads of ore have been shipped from the Star Antimony mine located on the ridge between the East Fork of Pine Creek and Stewart Creek. Stibnite forms the ore and occurs as a replacement both of crushed slate and vein quartz. A little pyrite and sphalerite are associated with the stibnite and the ore contains some gold. A rich streak of sheared stibnite up to 50 cm. in width occupies the center of the vein. The Pearson prospect on a tributary to Ross Fork of Pine Creek produced 50 tons of stibnite ore in 1916. The stibnite replaces sheared slate along a fissure and calcite crystals line cavities in the ore. Several tons of stibnite have also been obtained from the Hannibal claims 1,800 feet south of the Pearson.[37]

The Stanley antimony-gold mine in Gorge Gulch about a mile above Burke produced considerable stibnite ore in 1906 and again in 1915–16. The ore is coarse bladed stibnite in quartz which contains minute grains of yellow sphalerite. The country rock is slaty quartzite of the Burke formation and inclusions of wall rock in the quartz of the vein contain disseminated crystals of pyrite and arsenopyrite. The ore near the surface contains numerous secondary oxidation products.[38] Films of native gold occasionally coat rifts in the stibnite. Some small lenses of stibnite occur along a fissure in the

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[36] The above notes are from observations made by the writer in 1915 in company with Lon Brainerd, then manager of the mine. A more recent description appears by E. L. Jones, jr., Bull. U. S. Geol. Survey No. 710, p. 32, 1920.

[37] E. L. Jones, jr. U. S. Geol. Survey Bull. 710, pp. 33–34, 1920.

[38] Earl V. Shannon. Amer. Min., vol. 3, p. 23, 1918.

Benton mine which adjoins the Stanley. The Hougland mine, 8 miles from Burke has produced considerable stibnite from flat-lying quartz veins. At one time an oxide plant was operated at this property.

In the Coeur d'Alene district the stibnite occurs entirely in distinct antimony veins which have many features in common with each other, but are different from the several other classes of deposits in this region. Stibnite is not known to occur in galena-bearing veins, the so-called stibnite of the Gold Hunter, Bunker Hill, and other mines all being boulangerite or a related sulpho-salt of lead.

VALLEY COUNTY[39]

Stibnite, very clean and free from other sulphides, occurs on the rim of Yellow Pine Basin. The country rock is granite containing dikes of aplite and pegmatite and gold-bearing magmatic quartz veins. The sulphide ore reaches practically to the surface, there being only a thin skin of oxides. East of Johnson Creek there are two or three distinct quartz-stibnite veins. One of these which is traceable for 1,200 meters shows from 15 to 45 cm. of pure stibnite. At one point there are several lenses of practically pure antimony sulphide, the largest 1½ meters wide with a length of 10 to 12 meters. The stibnite occurs both as a vein filling and as an irregular replacement in the surrounding granite pegmatite formation. On the west side of Johnson Creek the cliffs rise abruptly from a steep talus slope. The cliff face, composed of a siliceous rock, possibly alaskite, is 150 meters high and over a mile long and contains sporadically distributed buches of stibnite. Bowlders in the talus of 3 or 4 tons weight are one-fourth this mineral which appears to represent segregated bunches throughout the rock mass of the cliff. Samples of the granitic rock of the region contain one-half of 1 per cent of antimony in microscopic grains. Similar deposits of antimony ore are reported from the same general region, notably at Cinnabar and near Edwardsburg.[40]

BISMUTHINITE (29)

BISMUTH GLANCE

Bismuth sulphide, Bi_2S_3. Orthorhombic.

BOISE COUNTY

Bismuthinite occurs commonly in several gold mines of the Boise Basin region where it has frequently been mistaken for stibnite.

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[39] A new county created from a part of Idaho County. Its localities for most minerals are mentioned under Idaho County.

[40] D. C. Livingston. Univ. of Idaho School of Mines Bull. 2, pp. 49–51, 1920. See also R. N. Bell. 20th Ann. Rept. Mining Industry of Idaho, p. 99, 1918.

In rich ore from the No. 4 tunnel of the Mountain Chief mine, Quartzburg district, it occurs as small grains and prisms showing brilliant cleavage scattered through quartz which contains large pale fragile crystals of pyrite. The mineral also occurs in the form of minute prisms in small cavities between quartz crystals, some of which are bent and curved like stibnite crystals. The mineral closely resembles galenobismutite from the Belzazzar mine in the same area but before the blowpipe it gave qualitative reactions only for bismuth and sulphur with no lead. A pure sample separated with heavy solutions and partially analyzed gave 0.60 per cent of lead and no copper. A crystal selected from one of the cavities of the specimen gave approximate measurements indicating the angles of bismuthinite but with 3 forms apparently new for this species. The angles are given in the following table while the habit and development of the crystal are shown in Figure 1. The letters used to designate the supposedly new forms are those assigned to the corresponding planes on stibnite. The differences between measured and calculated angles is due to the poor signals produced by the etched and striated faces.

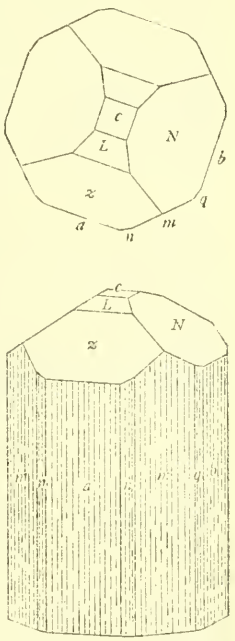

Fig. 1.—Bismuthinite. Crystal from Mountain Chief mine, Boise County, showing new forms (210), (023), and (103)

Forms and angles on bismuthinite from Boise County

Form		Symbol		Description, etc.	Measured		Calculated	
No.	Letter	Gdt.	Miller		φ	ρ	φ	ρ
					° ′	° ′	° ′	° ′
1	*c*	0	001	Very poor		0 00		0 00
2	*b*	0∞	010	G. striated	0 00	90 00	0 00	90 00
3	*a*	∞0	100	Very poor, blurred	90 00	90 00	90 00	90 00
4	*q*	∞3	130	Very poor, narrow	19 05	90 00	19 00	90 00
5	*m*	∞	110	Very good	44 57	90 00	45 65	90 00
6	New?	2∞	210	Very poor, dull	67 02	90 00	64 11	90 00
7	New?	0⅔	023	Dim poor	0 26	34 44	0 00	33 17
8	*z*	10	101	Good	90 00	47 15	90 00	45 30
9	New?	⅓0	103	Very poor	89 51	19 59	90 00	18 44

At the Gold Hill mine near Quartzburg bismuthinite frequently occurs as bunches of columnar or fibrous steel gray material in quartz gold ore. It always contains native gold.[41]

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[41] Waldemar Lindgren. Oral communication, May, 1921.

CUSTER COUNTY

Acicular steel gray needles of bismuthinite are present in massive pyrite, and disseminated grains and fibrous masses in quartz and altered granite, in the Empire Claims of the Idaho-Montgomery Mining Co. in Washington Basin at the head of Salmon River in Custer County. It is associated with a reddish sphalerite, pyrite, and barite, and alters to earthy bismuth carbonates.

WASHINGTON AND ADAMS COUNTIES

Bismuthinite occurs sparingly in the contact metamorphic copper deposits of the Seven Devils district and was doubtfully identified as microscopic grains in disseminated low-grade ore of the Red Ledge mine.[42] In the Heath district the same mineral is found in grains and granular masses with argentiferous pyrite in copper ores associated with garnet rock.[43]

GUANJUATITE (30)

Bismuth selenide, Bi_2Se_3. Orthorhombic.

LEMHI COUNTY

Guanajuatite is a very rare mineral which was known only as specimens from Guanajuato in Mexico until identified in specimens from Idaho by Dr. W. T. Schaller.[44] It occurs as dark gray grains and small masses (Cat. No. 93736 U.S.N.M.) in quartz in a claim belonging to Mr. John E. Ericksen, of Salmon, Idaho. The claim is located on Kirtley Creek, 9 miles northeast of Salmon and 1½ miles from the mouth of the creek.[45]

TETRADYMITE (31)

Bismuth telluride, Bi_2TeS_2. Rhombohedral.

CUSTER COUNTY

Tetradymite has been reported to occur in the ores of the Empire claims of the Idaho-Montgomery Mining Co. in Washington Basin.[46] The report has not been confirmed. All specimens showing bismuth minerals from this locality which were tested for tellurium by the writer gave negative results.

MOLYBDENITE (34)

Molybdenum sulphide, MoS_2. Hexagonal.

BONNER AND BOUNDARY COUNTIES

Molybdenite occurs on A. J. Kent's property near the road that runs to the Dora and Tungsten Hill tungsten mines. The country rock is granite and the mineral is found in a pegmatitic phase of this rock which consists chiefly of irregular bunches of quartz and muscovite. The molybdenite crystals are in some cases 2 cm. across and have a radiating structure, as have also the mica crystals with which it is associated. The deposit is irregular and bunchy and has been opened only by a few shallow open cuts.[47] Specimens in the National Museum labeled as from veins in granite 21 miles by trail southwest of Porthill, Idaho, consist of rosettes of molybdenite folia up to 1 centimeter in diameter in quartz with some mica (margarodite). Very small amounts of molybdenite occur in a quartz vein with pyrite in a small diorite intrusion south of Lakeview near Lake Pend d'Oreille.

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[42] D. C. Livingston and F. B. Laney. The copper deposits of the Seven Devils and adjacent districts. Idaho State Bur. Mines and Geol., Bull. 1, pages 52 and 66, 1920.

[43] R. N. Bell. Annual Report on Mining Industry of Idaho for 1905, page 141.

[44] Waldemar T. Schaller. U. S. Geol. Survey, Bull. 610, p. 137, 1916.

[45] John E. Ericksen. Personal letter, 1916.

[46] Engineering and Mining Journal, vol. 83, p. 23, 1907.

CUSTER COUNTY

Small scales of molybdenite are present in ore taken from the bins of the north tunnel of the Empire mine at Mackay where it is associated with chalcopyrite in garnet rock. Specimens from the Bay Horse district show small rosettes of molybdenite folia up to 7 millimeters in diameter in quartz. Others show weathered molybdenite partly altered to powellite. A sample sent to the National Museum by Dr. C. L. Kirtley from Challis shows small scales of molybdenite associated with quartz and pyrite in a heavy pyroxene rock.

ELMORE COUNTY

This mineral is also reported to occur in a vein on Sheep Creek. A specimen sent in by W. R. Decker from Pine, in Elmore County shows good foliated molybdenite partly altered to molybdite on granite.

IDAHO COUNTY

Molybdenite occurs on W. G. Cadby's claims 12 miles from Warren and one half mile west of the South Fork of Salmon River and four miles north of the wagon road between Warren and Dustins Ranch on the South Fork. It is associated with pyrrhotite in garnetized schist and hornblende sills, being usually in very fine grains, although crystals over a centimeter in diameter occur locally. The zone in which the molybdenite occurs is about 50 meters wide and 700 meters long.[48]

LEMHI COUNTY

Molybdenite forms thin films and coatings on fractures and minute scales intergrown with the primary minerals of the tungsten deposits of the Blue Wing district. Considerable amounts occur also on A. R. Mulkey's claim on west Eightmile Creek in the Lemhi Range 12 miles west of Leadore. The country rock is granite or monzonite and the mineral is contained in a very irregular or bunchy pegmatite vein. Several hundred kilograms of molybdenite were shipped from one small chute. A little scheelite occurs with the molybdenite. Adjoining this property is a deposit of oxidized copper ore containing chrysocolla and azurite.[49]

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[47] D. C. Livingston. Univ. of Idaho School of Mines Bull. 2, p. 40, 1919.

[48] D. C. Livingston. Univ. of Idaho School of Mines Bull. 2, p. 42, 1919.

LEWIS COUNTY

A little molybdenite occurs in the Horseman property in the Deer Creek Region in Lewis County, along with chalcopyrite in a gangue of siderite. The vein minerals occupy a vein and partly replace the crushed country rock, greenstone, along the fissured zone.[50]

WASHINGTON AND ADAMS COUNTIES

Molybdenite is present in almost all openings of the contact metamorphic copper deposits but is nowhere abundant. It is most common in ores of the lower Queen tunnel, but even here it is of little or no commercial importance.[51] A specimen from the lower Queen tunnel shows small rosettes of folia of molybdenite in quartz with pale green diopside. In one from The Blue Jacket mine flakes and scales of this mineral appear in coarse columnar dark green epidote associated with quartz containing small octahedrons of magnetite. A very little molybdenite occurs in minute flakes associated with chalcopyrite in quartz in Frenchy's claim.[52]

ARGENTITE (42)

SILVER GLANCE

Silver sulphide, Ag_2S. Isometric.

Argentite, the black silver sulphide, is of widespread occurrence in the silver mines of the central and southern portion of the State being among the most important of the primary silver ore minerals. It commonly takes the form of small disseminated grains and crusts and is very rarely in distinct crystals. Many of the richer silver ores consist of fine grained quartz containing argentite in grains so minute that the mineral appears merely as a black stain in the translucent quartz. Where it is in larger grains much of the argentite assumes a mossy or furred dull black appearance upon short exposure to the light and air. The mineral may be distinguished by its black color and marked sectility when in masses of sufficient size, but the identity of the very finely disseminated grains with argentite can only be inferred.

ADAMS COUNTY

Argentite is reported to have been present in rich oxidized silver ores formerly worked in the Ruthberg district, 18 miles north of Salubria, where it was associated with cerusite, native silver, and cerargyrite.

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[49] D. C. Livingston. Univ. of Idaho School of Mines. Bull. 2, p. 41.

[50] D. C. Livingston and F. B. Laney. Idaho, Bur. Mines. Bull. 1, p. 100, 1920.

[51] D. C. Livingston and F. B. Laney. Idem, p. 66.

[52] D. C. Livingston and F. B. Laney. Idem, p. 34.

BOISE COUNTY

In this county argentite has been one of the chief ore minerals mined in the rich silver-bearing quartz veins in granite in the Banner district where it is associated with stephanite, pyrargyrite, and native silver with some pyrite and sphalerite. The ore is exceedingly rich in streaks. In the Quartzburg district argentite was associated with stains of copper carbonate and iron arsenates as a small amount of rich silver ore mined from two narrow veins on Clear Creek three miles southwest of the Star ranch. Specimens from the old Washington mine, Idaho City district show small sectile masses of argentite associated with stephanite in quartz.

BLAINE COUNTY

Argentite is present in small grains with proustite, cerargyrite, tetrahedrite, smithsonite, and cerusite in the ores of the Ella mine near the head of Ella Canyon in the Era district and also in the Silver King and Vienna mines. A specimen from the old Neptune mine (Cat. No. 56536, U.S.N.M.) shows mossy black grains of argentite associated with leafy native silver in altered granite.

CUSTER COUNTY

In Custer county silver glance is rather abundant in the rich oxidized ores of the Late Tertiary veins.[53] In the Bay Horse district it occurs in small amount with leafy and wire silver, cerargyrite, pyrargyrite, carbonates of copper, and native copper in the oxidized ore of the Skylark mine; and also with the same minerals in much of the ore of the Riverview mine. In the Yankee Fork district the sulphide forms small grains in the oxidized ore of the General Custer mine with wire silver, cerargyrite, manganese oxides, and malachite. (Cat. No. 56527, U.S.N.M.)

ELMORE COUNTY

In the rich ores of the Atlanta lode, Atlanta district, argentite occurred in the form of mossy grains (Cat. No. 51864, U.S.N.M.) but was greatly subordinate to stephanite and pyrargyrite in most of the ore.[54]

IDAHO COUNTY

Argentite has been reported as a constituent of rich ore from the Little Giant vein, Warren district, associated with tellurides, native silver and gold.[55]

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[53] J. B. Umpleby. Some ore deposits of northwestern Custer County, Idaho. Bull. U. S. Geol. Survey 539, p. 52, 1913.

[54] Joshua E. Clayton. Trans. Amer. Inst. Min. Eng., vol. 5, p. 471, 1876.

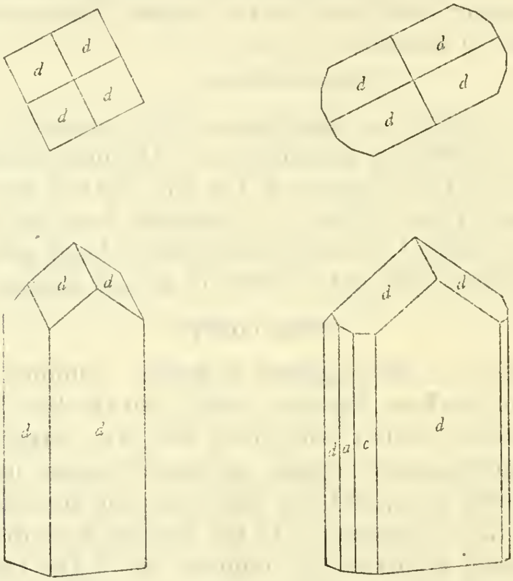
[55] Waldemar Lindgren. U. S. Geol. Survey, 20th Ann. Rept., pt. 3, p. 246, 1899.

LEMHI COUNTY

Argentite has been noted in small amounts in the Pittsburg-Idaho mine.[56]

OWYHEE COUNTY

In Owyhee County argentite is a very common ore mineral in the Silver City and De Lamar districts where it occurs in the Black Jack, Trade Dollar, and numerous other mines usually as finely disseminated grains in quartz. It often forms crusts surrounding fragments of granite included in the veins (pl. 1) and the argentite layers are frequently surmounted by a comb of quartz crystals (pl. 4, lower). In the Poorman mine argentite was nowhere very abundant but it occurred occasionally as rich streaks of finely disseminated grains in quartz (Cat. No. 14799, U. S. N. M.). In the De Lamar mine this mineral was almost universally present in the silver ores as fine aggregates in quartz or as thin sheets on the walls of narrow veins. It also occurred commonly as nodular or rounded masses inclosed in white clay and ranging in size from small shot to some which were as large as an egg.[57] In the War Eagle mine argentite, finely disseminated in minute grains, constituted rich black streaks in dense quartz containing cavities lined with valencianite crystals



2 3

FIGS. 2-3.—2, ARGENTITE. ELONGATED DODECAHEDRAL CRYSTAL. 3, ARGENTITE. DISTORTED CRYSTAL SIMULATING ORTHORHOMBIC SYMMETRY and impregnated with cerargyrite in the more open cellular portions. In the ore from the Pauper mine it also forms rich streaks of scattered microscopic grains in coarse comb quartz in granite. In the Henrietta mine argentite occurs also in small grains disseminated in quartz which bears crusts of miargyrite crystals. (Cat. No. 14809, U.S.N.M.) A specimen from the Trade Dollar mine, 1,300 foot level contains a heavy mass of sectile argentite 5 cm. square and averaging 1 cm. thick, in quartz. Near the borders of the mass the argentite contains intergrown chalcopyrite. Specimens of ore from a raise 1,300 feet from the portal of the Blaine tunnel, Silver City district show argentite as finely disseminated grains with chalcopyrite in a quartz-adularia aggregate and as dull crystals of small size resting upon druses of quartz crystals in cavities. In the Flint district argentite occurs in several mines. In the Rising Star mine it forms scattered fairly large grains in quartz with polybasite, grains of stephanite, pyrargyrite, stromeyerite, and xanthoconite and blades of stibnite.

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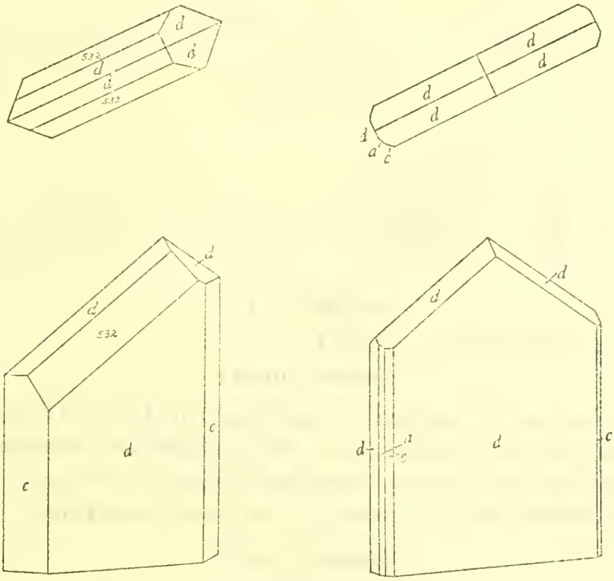
[56] J. B. Umpleby. U. S. Geol. Survey Bull. 528, p. 75, 1913.

[57] Waldemar Lindgren. Gold and silver veins in Idaho. U. S. Geol. Survey, 20th Ann. Rept., pt. 3, p. 168, 1900. Some of these nodules of so-called argentite have since been found to be naumannite.



Figs. 4-5.—Argentite. Distorted crystals. Coeur d'Alene district

SHOSHONE COUNTY

In Shoshone County argentite has been reported to occur disseminated in quartz in silver ore from the Big Creek mine on Big Creek, and it probably occurs mixed with sooty covellite in rich silver ores from the Caledonia mine.

A group of specimens in the Museum collections (Cat. No. 85032, U.S.N.M.) received from the United States Geological Survey labeled as from "Coeur d'Alene, Kootenai County, Idaho," is doubtless from some mine in the Coeur d'Alene district. These are very rich, consisting entirely of native silver in curved columns and wires on masses of crystallized argentite which forms spongy masses. The crystals of silver sulphide are distinctly orthorhombic in appearance and were thought to be acanthite. Careful measurement of a number of them, however, indicated that the angles were not those of acanthite but that the prismatic and tabular forms were elongated and distorted dodecahedrons with various modifying faces. Four different habits are shown in Figures 2 to 5. These crystals, upon measurement, gave the following angles:

Measurement of argentite from the Coeur d'Alenes

Form		Symbol		Quality, description	Measured		Calculated	
No.	Letter	Miller	Gdt.		φ	ρ	φ	ρ
					° ′	° ′	° ′	° ′
1	*c*	010	0∞	Poor, dull	0 31	90 00	0 00	90 00
2	*d*	110	∞	Very good, excellent	45 00	90 00	45 00	90 00
3		011	01	Medium	0 44	44 15	0 00	45 00
4	*a*	130	∞3	Very poor	18 59	90 00	18 26	90 00
5		532	$\frac{5}{2}\frac{3}{2}$	Medium	30 10	70 41	30 58	71 04

PETZITE (44)

Telluride of silver and gold, $(Ag, Au)_2Te$. Massive.

IDAHO COUNTY

Petzite has been reported to occur in the Black Diamond mine in the Dixie district in a streak of ore 18 inches (50 centimeters) wide from which assays of several hundred dollars in gold were obtained. The identification of the mineral has not been confirmed.

GALENA (45)

LEAD GLANCE

Lead sulphide, PbS. Isometric.

Galena is a mineral found in Idaho in greater or less amount in practically every mining district and in all classes of mineral deposits. It is the essential primary mineral of the lead-silver ores, the most important of which are those in the Coeur d'Alene district in Shoshone County and in the Wood River district in Blaine County, although valuable individual lead mines are operated in Custer, Lemhi, and other counties. Less abundantly this mineral occurs throughout the State as an accessory constituent of gold, silver, and copper ores. In the silver and lead-silver deposits the galena commonly contains more or less silver while in gold veins it is usually gold bearing. Well crystallized specimens are not known from any locality of the State, euhedral crystals being exceedingly rare and of small size. The following discussion, while not exhaustive, mentions the principal known localities and occurrences.

ADA COUNTY

Galena occurs sparingly in quartz with arsenopyrite, pyrite, and sphalerite in gold ores of the Black Hornet and Boise districts.

BANNOCK COUNTY

In the Fort Hall district, Fort Hall mine, galena is found in granular masses with chalcopyrite in a gangue of white calcite.

BEAR LAKE COUNTY

In the St. Charles district galena occurs in a number of undeveloped prospects in the Bear River Range near Paris where it has formed, apparently, by replacement of limestone. The mineral appears as pure rounded lumps altered on the outside to cerusite and embedded in siderite and dolomite.[58]

BLAINE COUNTY

In the Antelope district galena has been mined from the Climax and Silver King claims on Lead Belt Gulch, a tributary to Antelope Creek northeast of Muldoon.

In the Dome district galena is mined in the Wilbert mine and occurs in a number of prospects. Specimens from the Wilbert mine show a fine grained form of the mineral disseminated in quartzite in minute grains and as seams, and occurring as the cement of a quartzite breccia and laminated with crushed quartzite gouge. Much of the ore consists of quartzite colored dark gray by microscopic grains of galena. In the Johnson prospect the galena occurs in bunches in the country rock along fissures.[59]

In the Elkhorn (Ketchum) district large amounts of galena have been mined from a large number of mines, most important among which are the Elkhorn, Quaker City, Parker, Independence, and North Star. A specimen from the Elkhorn mine shows moderately fine-grained galena with pyrite in white quartz. In a shallow sag near the top of the hill on the Elkhorn claim there occurred a great quantity of placer galena and cerusite which could be shoveled up and jigged. The ore consisted of galena partly altered to cerusite and in the richest part of the upper vein a body 3½ meters thick was mined.[60] The galena contains from 80 to 148 ounces of silver a ton. The gangue is calcite, quartz, and siderite. In the Independence mine the galena occurs in relatively large pure masses and is much less contaminated with objectionable sulphides than that in North Star ore, although boulangerite is commonly associated. In the North Star mine, which is on the East Fork of Wood River, the ore below the oxidized zone consists of galena with pyrite, sphalerite, arsenopyrite, and boulangerite.

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[58] R. W. Richards. Notes on lead and copper deposits in the Bear River Range, Idaho and Utah, U. S. Geol. Survey Bull. 470, 1911, pp. 177-187.

[59] J. B. Umpleby. U. S. Geol. Survey Prof. Paper 97, p. 117, 1917.

[60] Waldemar Lindgren. Gold and Silver veins in Idaho. U. S. Geol. Survey. 20th Ann. Rept., pt. 3, p. 210, 1900.

In the Era district argentiferous galena is the principal ore mineral. In the St. Louis and Reliance mines it is present in rather small amount and is associated intimately with wurtzite and is occasionally in distinct crystals, which are either cubes or cuboctahedrons. In the Reliance mine a little jamesonite occurs with the galena.

In the Hamilton or Clyde district galena bearing ores have been mined in prospects in Badger Creek Canyon 9 miles southeast of Clyde.

In the Lava Creek district galena occurs in silver ores where it is associated with proustite, stephanite, etc., in brecciated veins in volcanic rocks. A specimen from the Hub which is the principal mine shows coarse granular galena with a little sphalerite of like texture and fine crystals of pyrite in a gangue of calcite and rhodochrosite.

In the Little Smoky district a number of veins carrying galena have been worked to some extent, the Tyrannus mine having produced some ore.

The Little Wood River or Muldoon district has yielded some galena ore, principally from the Muldoon mine where this mineral is associated with some sphalerite and pyrite as a replacement of quartzites which are probably of Carboniferous age. On the Drummond claim galena occurs in what appears to be a contact-metamorphic deposit in fine grained intergrowths with copper sulphides and lime silicates.

The Mineral Hill or Hailey district which together with the Elkhorn or Ketchum district is usually called the Wood River district, is, aside from the Coeur d' Alene region, the most important lead-mining district in the State. The lead-silver mines of this district are noted for their large bodies of pure galena of which the Minnie Moore mine is the best-known deposit. The galena from this mine occurs in masses of coarse granular texture. Some of these individuals are 5 to 8 centimeters in diameter and all specimens show a more or less distinct lamellar structure, or a striation on certain cubical cleavage planes which on close examination is found to be identical with the lamination in character. The regularity of this structure is not evident in many pieces, but appears very distinctly in others, and by means of numerous transition stages all forms of banding are seen to represent definitely one of two phenomena. The first of these is where a banding appearing on a cleavage face results from a series of undulations parallel to one diagonal of the cube. The reflection is seen to be simultaneous in alternate bands and to be continuous from one position to the other, for the surface is simply folded. Tracing the bands over to other faces of the cleavage cube, they are seen to run parallel to the cleavage lines, not diagonal. They are thus parallel to the plane (110). Bauer found in his experiment that a motion or slipping was produced parallel to (110) and this is clearly an instance of the same movement. Another structure, more sharply defined than the last, is caused by an alternation of laminae with definite formal relations to each other. These are sometimes thin, appearing as mere striations, but may have a thickness of 2 centimeters or more. These laminae do not always occupy the same position but are inserted parallel to several different crystal planes. The law of twinning represented by many of these laminae is: Twinning plane (331); axis, the normal of the twinning plane. The structure of the galena showing this twinning is very complex and has not been entirely worked out.

Apparently several planes of twinning are present, all of which lie in the zone 001 ∧ 110, and including a number of different trapezohedrons. The form (441) is mentioned as a twinning plane for galena by Sadebeck, and (131) by Zepharovich. In small fragments twinning laminae occur parallel to the octahedron (111). By careful examination of many of these specimens striations are seen running at regular angles with the lines of the cubic cleavage. By measuring these inclinations under the microscope, the faces parallel to which the laminae causing the striations are inserted may be determined. This twinned structure is certainly secondary and probably due to pressure. In the specimens the evidence of pressure is very marked, and the distorted forms of the masses which are included by the cleavage planes are sometimes very striking. These should be cubes but are in fact rhombs or bodies with unsymmetrical shape. Faces which are not regularly disturbed by the slipping parallel to (110) are often curved and show indistinct development of one or the other of the twinning forms. It seems that the pressure manifested itself in accordance with the position in which a given individual lay with regard to the pressure. Sometimes the force could be all applied to the production of one form of twinning; sometimes it resolved into several elements of pressure, each availing itself of the plane of weakness most suitable for its manifestation and hence different twinnings and slippings are developed all in one piece. In many places, probably in the greater part of the mass of the ore, the galena has been simply crushed, as is illustrated by specimens with slickensided surfaces. Again a very thin and fine lamination has been produced, combined with much fracturing, so that the law of the structure has been obscured.[61]

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[61] Whitman Cross. Proc. Colorado Sci. Soc., vol. 2, p. 171, 1885. The discussion by Cross, reprinted here with slight changes in wording was the first accurate and lucid discussion of the crystallographic processes leading to the production of the banded and gneissic twinned structure in galena which is common in Idaho and elsewhere and which has since been described by several other writers.

This description of galena from the Minnie Moore also applies to the mineral from other mines of the district. The galena, always the most prominent mineral, is often coarsely granular with parallel orientation over large areas, though the very fine grained dense variety known as steel galena occasionally occurs. The twin striation described above is almost universally present in all veins; and this gives the mineral a peculiar fibrous appearance, the striation being parallel to the walls of the vein and doubtless being everywhere due to pressure. In many places galena is almost the only ore mineral and is associated with a little siderite or intermediate carbonates which frequently form a lining about the bodies of galena. Banding indicating filled cavities appears in the smaller veins. Ore from the Democrat vein in granite is banded and shows quartz, calcite, galena, and tetrahedrite deposited in the order named. The galena was twinned by the same movement which shattered the tetrahedrite. Second-grade ore may consist of a network of seams of siderite or intermediate carbonates cutting black calcareous shale. The galena then usually appears as grains in the veinlets; more rarely it lies directly in the sedimentary rocks. In the mines of the Democrat type pyrite, galena, and zinc blende may also occur as abundant grains directly inclosed in the altered granite. Many of the Wood River mines are noted for the heavy bodies of practically pure galena occurring in them. The Minnie Moore in one stope showed 16 feet of solid galena.[62]

In the Rosetta and Warm Springs districts galena occurs in a number of mines. Specimens from the Dollarhide mine show it in a granular form in quartz with sphalerite and arsenopyrite, and ore from the Golden Glow mine consists of granular massive galena in quartzite. The ore of the New Hope (Warfield) property on Warm Springs Creek consists of pure fine grained massive galena with very fine grained sphalerite.

BOISE COUNTY

In the Banner district galena is a rare constituent of the rich silver ores of the Banner and adjacent mines.

In the Deadwood district this mineral in granular masses has been noted in ore from Hall Bros. property, Deadwood Basin.

In the Highland Valley, Idaho City, and Quartzburg districts galena occurs in the primary gold ores below the oxidized zone as disseminated grains in quartz with pyrite, arsenopyrite, and, more rarely, chalcopyrite, bismuthinite, and galenobismutite. The galena frequently carries gold.

The occurrence of lead sulphide in the Summit Flat (Pioneerville) district is similar to the last. Ore from the stope below the upper tunnel of the Golden Age mine shows galena as relatively coarse grains with sphalerite, pyrite, and tetrahedrite admixed with crushed quartz in altered sericitized granite. Ore from the Gem of the Mountains mine has coarse granular galena with pyrite and arsenopyrite in quartz and in ore from the Overlook mine galena in perfect cubic cleavages up to 1 centimeter in diameter occurs with pyrite, sphalerite, and tetrahedrite. In some specimens from the latter mine the gangue contains calcite and in one instance the galena crystals are surrounded by a thin layer of chalcopyrite which penetrates them along cleavage cracks and is evidently of later age.

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[62] Waldemar Lindgren. U. S. Geol. Survey, 20th Ann. Rept., vol. 3, pp. 214–215.

In the Westview (Willow Creek, Pearl, Rock Creek) district galena is a common constituent of the masses of auriferous sulphides which make up the primary gold ores in granite. In ore from the Checkmate mine this mineral is intergrown with pyrite and sphalerite in 3 cm. seams of metallic sulphides in quartz-seamed altered granite containing disseminated arsenopyrite. Ore from the Lincoln mine has small crystals of galena of cuboctahedral habit in vugs in masses of brown sphalerite. The galena from this district is frequently highly auriferous; a pure specimen from the Sacramento mine assayed 8 ounces of gold and 67 ounces of silver a ton.

BONNER COUNTY (including BOUNDARY COUNTY)

Galena occurs in a number of lead prospects and partly developed mines in Bonner and Boundary counties.

In the East Shore or Clark Fork district the principal lead mine is the Lawrence, 1½ miles northeast of Clark Fork. The ore here is clean galena in veins and lenses up to 3 feet wide. It is very pure, showing only a little sphalerite and pyrite and some siderite gangue. Much of it exhibits gneissic structure and highly polished galena veneered slickensides are found in the ore. In the Marguerite prospect on Trestle Creek about 1 mile north of the lake, galena occurs in quartz with pyrrhotite, sphalerite, and chalcopyrite. This mineral also occurs in the Morning Star vein 1 mile east of Hope with chalcopyrite and sphalerite in a quartz gangue. The production of the district has been small.

In the Mooyie Yaak district galena occurs with native gold in the Buckhorn and Dora mines and associated with chalcopyrite and sphalerite in the Copper Queen mine and other prospects.

In the Pend d'Oreille district some galena-bearing silver ores have have been developed especially about Blacktail Mountain where the galena is associated with tetrahedrite.

CUSTER COUNTY

In the Alder Creek district only small amounts of galena have been found. On the Kennedy group claims near mineral monument

No. 1 it occurs in a siderite gangue in veins in granite. In tunnel No. 2 of the Champion group claims galena appears as irregular bunches in limestone and on the Easlie claims it occurs along the contact of granite porphyry and an engulfed block of limestone. Two or three carloads of mixed ore, chiefly galena, have been shipped from the district.[63]

In the Bayhorse district galena bearing lead-silver ores have been mined from a number of scattered mines, the most productive of which have been the Beardsley-Excelsior and Red Bird. Other important lead mines are the River View, Ella, Forest Rose, and Dougherty. Most of the mines are inclosed in dolomitic limestones but the Livingston and part of the Red Bird are in slate. The primary ores consist mainly of argentiferous galena with unimportant amounts of tetrahedrite, sphalerite, pyrite, and chalcopyrite. The gangue is chiefly quartz and siderite. The ores are to a considerable extent oxidized to cerusite, etc.[64] The galena is for the most part massive and of comparatively coarse grain. Specimens from the Cave mine show masses of pressure-distorted coarse grained galena surrounded by anglesite, and again fine-grained steel galena altering to massive cerusite and bindheimite. Galena is also an accessory mineral in the silver-copper ores of the same district with chalcopyrite and arsenopyrite in the midst of predominant tetrahedrite and siderite. A specimen of such ore from the Utah Boy No. 5 tunnel, Ramshorn mine contains galena as small imperfect cuboctahedral crystals in cavities in siderite-tetrahedrite ore.

In the East Fork or Copper Basin district galena is present as replacement deposits along fissured zones in quartzite. The Starr Hope is the principal mine. The galena, which is partly oxidized, occurs in a bluish quartz gangue. There are several lead prospects also close to the head of Lost River near the Trail Creek Summit. The Phi Kappa mine in Phi Kappa Canyon has been opened to some extent. Ore from this mine is interesting as showing granular galena, with sphalerite and chalcopyrite disseminated sparingly in granular massive grayish garnet. Galena also occurs in a prospect at the head of Little Fall Creek in the same region in coarse grains associated with pyrite in calcite.

In the Loon Creek (Casto, Lost Packer) district galena occurs on the Lost Eagle claim in Algonkian schist with some pyrite and chalcopyrite in a quartz siderite gangue, and in a vein in granite cutting the Metcalf property from which large pure specimens of coarse cleavable galena have been obtained. Neither has made any important production.[65]

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[63] J. B. Umpleby. U. S. Geol. Survey Prof. Paper 97, p. 53, 1917.

[64] J. B. Umpleby. U. S. Geol. Survey Bull. 539, pp. 59–76, 1913.

[65] J. B. Umpleby. Bull. 539, p. 99, 1913.

In the Sheep Mountain district galena is found in several mines. In the Golconda claim a quartz vein in limestone contains it associated with pyrite, sphalerite, and pyrrhotite. The King property produced considerable amounts of lead silver ore consisting of galena containing up to 170 ounces silver a ton, together with pyrite, sphalerite, and a little chalcopyrite in a quartz gangue in limestone. Galena occurs also in the Bulldog, Lakeview, Silver Bell, and other prospects in this district.[66]

ELMORE COUNTY

In the Atlanta district highly argentiferous coarse-grained galena is a common constituent of the rich silver ores of the Atlanta lode (Cat. No. 30199, U.S.N.M.) where it is associated with stephanite and pyrargyrite.

In the Neal district galena is an accessory mineral together with pyrite and sphalerite in the gold ores. The galena constitutes less than 1 per cent of the ore and assays as high as 167 ounces silver and 7 ounces gold a ton. In general, however, gold is more intimately associated with pyrite and silver with galena.

In the Rocky Bar district galena is a mineral of minor importance in the primary ores of the sulphidic gold quartz veins.

FREMONT COUNTY

In the Skull Canyon (Kaufman) district galena occurs in the Kaufman and Weaver claims with the oxidation products cerusite and a little plumbojarosite cementing a brecciated shaly limestone. In the Weimer copper mine galena forms kidney-shaped masses in the copper ore with cerusite and wulfenite.

In the Birch Creek district there is galena in the Birch Creek mine, associated with anglesite, cerusite, wulfenite, and smithsonite. The galena occurs both as the fine grained steel variety and as cubes. Some cubic crystals up to 2 cm. in diameter are isolated in yellow jasper. Nodules of galena are surrounded by concentric zones of oxidation products.

IDAHO COUNTY

In the Big Creek district some galena ore occurs with pyrite in a crushed zone in limestone along a rhyolite dike.

In the Dixie district galena is occasional as an accessory sulphide in gold quartz ores. A specimen of ore from the Mallard Creek prospect shows granular galena, altering to pyromorphite, admixed with light yellow sphalerite in quartz. The gold in these veins is usually rather intimately associated with the galena.

In the Elk City district galena is of rather common occurrence with pyrite as scattered bright grains in white quartz, as in specimens from the Hercules and Blue Ribbon mines. Ore from the Black Pine mine shows disseminated galena in quartz with gold, pyrite, sphalerite and tetrahedrite. The gold occurs as small grains around the borders of the galena grains.

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[66] J. B. Umpleby and D. C. Livingston. A Reconnaissance in South Central Idaho. Idaho State Bur. Mines and Geol. Bull. 3, p. 17–21, 1920.

Galena appears in similar manner in most of the gold mines of the county.

KOOTENAI COUNTY

In the Lakeview District south of the south end of Lake Pend d'Oreille galena occurs in a number of silver mines and prospects associated with tetrahedrite, etc.

LATAH COUNTY

In Latah County moderate amounts of galena have been mined from the Snowshoe mine near Troy.

LEMHI COUNTY

In the Blue Wing district galena is present in small amounts in the ores associated with pyrite, sphalerite, tetrahedrite, hubnerite, molybdenite, and chalcopyrite. It forms fine grained masses and a few small cubes. It is not conspicuous in the ore.[67]

In the Carmen Creek district galena occurs in small amount with pyrite, chalcopyrite, and sphalerite in unoxidized remnants of primary gold ore in the Oro Cache mine.

In the Eldorado (Geertson) district a very little galena is associated with gold in the Eldorado and Ranger mines.

In the Eureka district galena occurs rarely in gold ores of the U. P. & Burlington, Queen of the Hills, and Tenday mines.

In the Junction district lead-silver ore is mined in the Leadville mine and a number of prospects. The ore of this mine is predominantly fine grained steel galena with some pyrite and very rare chalcopyrite and sphalerite.

In the Kirtley Creek district the White Horse gold lode contains a little galena associated with pyrite and chalcopyrite.

In the Mackinaw district a subordinate amount of galena occurs in gold ore on the Italian property. It is associated with chalcopyrite and sphalerite and pyrite in coarse textured bluish white quartz Galena bearing lead ore is reported from the Bull of the Woods mine near Leesburg.

The gold ore of the Goldstone mine in the Pratt Creek district shows galena in scattered grains, with chalcopyrite in quartz.

The Spring Mountain district is a lead-silver mining region in which a number of mines have produced ores from veins in limestone. The ore is galena, in considerable part oxidized. The Lemhi Union, Colorado, Elizabeth, Teddy, Red Warrior, Iron Mask, Galena, and Excelsior are important mines.

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[67] J. B. Umpleby. U. S. Geol. Surv. Bull. 528, p. 111, 1913.

The Texas Creek (Gilmore) district is also a lead-silver district the primary ores of which consist of galena with some pyrite and sphalerite. Unoxidized ore is rare, however, most of the lead being in the form of carbonate. The Pittsburg-Idaho, Latest-out, and Allie are the principal mines. The galena is for the most part in the form of coarse cleavages forming residual cores in massive cerusite. (Cat. No. 56528, U.S.N.M.) Specimens of coarse cleavable galena from the Pittsburg-Idaho mine show very perfect twinning like that described in galena from the Minnie Moore mine, Blaine County.

OWYHEE COUNTY

In the rich silver ores of the Carson (War Eagle, Silver City, Florida Mountain) district galena is rare except in the Trade Dollar mine where it occurs as scattered grains in the richer ores.

Ore from the Bergh mine, 11 miles north of De Lamar, contains heavy sulphide masses consisting of galena in coarse cleavages intergrown with sphalerite and pyrite. Such ore is said to run $50 a ton in gold.

A specimen of ore from the Flint district, old Leviathan mine, consists very largely of coarse cleavages of galena, in considerable part oxidized to ashy gray anglesite which preserves, pseudomorphous, the cubic structure of the original mineral. Masses of coarsely crystalline feldspar occur in small amount included in the galena.

The South Mountain district, now nearly abandoned, in former years produced considerable amounts of argentiferous lead ore consisting of galena and its alteration products. Specimens in the National Museum show the character of the ores to be as follows: Rocksyfellow mine (Cat. No. 14822, U.S.N.M.), coarse granular galena in masses with perfect undistorted cubic cleavage, altered in part to earthy cerusite, anglesite, and bindheimite; Washington mine. Coarse granular argentiferous galena with massive cerusite in iron-stained rock; Yreka mine (Cat. No. 65663, U.S.N.M.), granular galena with earthy oxidation products; Monkey mine (Cat. No. 14539, U.S.N.M.), coarse granular galena altering to bindheimite and linarite. Primary ore from the Golconda mine (Cat. No. 65677, U.S.N.M.) is moderately coarse granular galena with pyrite and partly oxidized material shows coarsely granular galena partly altered to white glassy cerusite with sparingly developed minium and bindheimite. The Golconda ore occurs in crystalline limestone and is apparently of contact metamorphic origin, being associated with garnet, pyroxene, and ilvaite. Much of the unaltered ore from this mine is refractory, being intimately mixed with pyrite arsenopyrite, sphalerite, etc.

SHOSHONE COUNTY

The region in Shoshone County known generally as the Coeur d'Alene district is the greatest galena-producing area of its size in the world. The ores which have made the vast production occur in fissure veins in a thick series of sedimentary rocks of Algonkian age. Near Burke the principal mines are the Hercules, Tiger-Poorman, Marsh, Benton, Hecla, Standard-Mammoth, Greenhill-Cleveland, and Frisco. The Hercules is perhaps the richest body of galena in the district. It is reported that a raise driven for 40 meters (125 feet) in the vein was in granular galena showing no other material on any part of the walls throughout the entire length. In 1914 there was exposed in one stope of this mine a body of galena 12 meters (40 feet) wide which was very nearly pure. The ores of the Hercules mine are relatively free from other sulphides, although some tetrahedrite, pyrite, sphalerite, and pyrrhotite occur. The Benton mine has produced galena ore rather free from zinc but containing more or less pyrite and chalcopyrite. This vein is cut off at shallow depth by a fault and its continuation has not been found. The Hecla is another vein which produces galena relatively free from objectionable sulphides, and the ore of the adjoining Marsh mine is similar. The Tiger-Poorman vein system was very productive, but at depth the ore became so contaminated with pyrrhotite, pyrite, and sphalerite that it could not be worked profitably. The Standard-Mammoth and Greenhill-Cleveland ore shoots also were very productive of galena ore, but both became increasingly poorer with depth. The ore from the bottom levels of these ore bodies consisted of galena mixed and intergrown with magnetite, sphalerite, pyrite, pyrrhotite, and chalcopyrite. Clean masses of galena and silver-bearing minerals were, however, sparingly present in the lower levels filling later fractures in the old complex mineralization. These minerals included chalcostibite, boulangerite, chalcopyrite, and pyrargyrite. The Frisco vein contains galena very much intergrown with sphalerite, pyrrhotite, etc. It has not been profitably worked in the lower levels. These mines all occur in the slaty sericitic quartzites of the Burke formation and occupy fissure veins of high dip. The ore is for the most part confined to the fissure and replaces the gouge and brecciated rock of the vein. The gangue minerals are quartz and siderite.

Near Mullan the principal lead mines are the Morning, Hunter, and Star. The Morning produces some clean galena ore from veins in the Revett formation. Much of the ore is a complex mixture of sulphides and the ore of the adjoining Star mine is a very intimate mixture of galena and sphalerite. The Hunter mine, which is the only important lead mine in the Wallace formation, has galena ore containing some tetrahedrite and other sulphides in a gangue of quartz and siderite. In parts of the vein fine-grained galena forms thin sheets in barite. Boulangerite is a constant accessory mineral in the ore. In the Little Giant claim, high on the flanks of Stevens peak opposite the Gold Hunter, galena occurs as scattered coarse grains and bunches in a vein of barite.

In the Ninemile Basin the principal mines are the Interstate-Callahan, Clarke or Sunset, Success (Granite), Rex (16 to 1), and Tamarack. The last is in the Burke formation but the others are in the blue slaty rocks of the Prichard formation and contain more sphalerite than galena. The Success mine is located on the border of an intrusive mass of monzonitic rock and the galena and sphalerite are intergrown with metamorphic silicates.

Between Wallace and Kellogg there are several mines opened on veins in the Wallace formation. These are narrow and crooked and are noted for the high silver content of their ore, which consists largely of tetrahedrite with less galena and pyrite and a little specularite in a coarse gangue of quartz and buff manganiferous siderite· The Yankee Boy and Polaris mines belong to this group.

At Wardner the Bunker Hill mine has opened ore bodies of various types, most of them being replacement deposits in quartzite of the Revett formation. These are largely galena ores in a siderite gangue and are for the most part free from objectionable amounts of sphalerite. Some of the ores are high grade, a mass in the Marsh stope showing a diameter of 40 feet of pure galena. The Last Chance mine has mined large amounts of galena ore, as has also the Tyler. The Caledonia, Stewart, Sierra Nevada, Crown Point, Silver King, and Ontario are mines in quartzite west of the Bunker Hill group which are noted as having produced large amounts of galena free from contaminating minerals. In part the ore bodies are flat lying masses of fine-grained galena in much crushed quartzite nearly free from other gangue. A small amount of barite has been found in the Caledonia, Stewart, and Crown Point mines.

Near Kellogg there are a number of galena-bearing prospects in the Prichard formation, none of which have been commercially productive. Typical of this group may be mentioned the Lombardy in Italian Gulch north of Kellogg and the Teddy, 3 miles west. The galena in most cases seems to be a later introduction in veins consisting of quartz containing large amounts of pyrrhotite, pyrite, and ankerite with some chalcopyrite. The majority of such veins in this group do not carry galena.

On Pine Creek a large number of mines have been opened on similar veins in the Prichard formation, most of which carry considerable amounts of both galena and sphalerite, with large quantities of iron sulphides. Among these may be mentioned the Highland-Surprise, Hilarity, Douglas, Constitution, Nabob, Sidney, and Little

Pittsburg. In some of these ores the sphalerite occurs in separate streaks and bunches but the majority of the ores the two minerals are intergrown in dense masses in microscopic grains, the aggregate looking like neither mineral. A small group of prospects differs from the majority of Pine Creek mines in that the ore consists of relatively clean granular galena with ankerite in white quartz. These are all adjacent to the quartzitic member of the middle Prichard formation. The principal mines of this group are the Lookout Mountain, Hypotheek, Northern Light, and Carbonate.

In the drainage basin of the North Fork of the Coeur d'Alene district a number of galena-bearing veins have been opened in the Prichard formation, some of which have fairly clean galena, while in others the galena is intimately mixed with sphalerite. Prominent among these are the Paragon, Jack Waite, Terrible Edith, Monarch, and Bear Top mines.

Galena occurs also in grains and masses in the gold veins near Murray with auriferous pyrite, chalcopyrite, and scheelite.

The galena from all of the principal mines of the Coeur d' Alene region is granular, usually of medium grain but varying from the very fine grained material called steel galena to rare occurrences where cleavages several centimeters broad are obtained. The very finest grained material is homogeneous and sectile and shows no visible cleavages whatever. In most cases this very fine material seems to have been reground, as it occurs along fissures, contains polished galena-faced slickensides, and grades into varieties having gneissic structure. Gneissic structures, obviously due to pressure, are very common in galena of various grain sizes. A small ore body in the Alhambra mine has galena which has been ground along a fissure and rehardened so that it resembles black graphitic slate. The coarser cleavages are usually bent, crumpled, or folded as in the mineral from the Minnie Moore mine in Blaine County.

The galena is all argentiferous, the average in the Bunker Hill mine being from 40 to 60 ounces of silver to the ton, although in other mines, notably the Hercules, the silver content is higher. The higher silver values accompany tetrahedrite and the silver may all be contained in this mineral. Specimens of galena from the Bunker Hill mine showing 0.08 per cent and 0.09 per cent of silver, respectively, proved to contain microscopic grains of tetrahedrite when examined on polished surfaces with the metallographic microscope as did specimens containing 0.108 per cent of silver from the Hercules mine.[68]

The galena is practically always massive, crystals with euhedral faces being exceedingly rare and of small size.

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[68] F. N. Guild. A microscopic study of the silver ores and their associated minerals. Economic Geology, vol. 12, pp. 305–306, 1917.

WASHINGTON COUNTY

In the Heath district galena, partly oxidized, occurs in a number of properties which have been worked to some extent for lead and silver. Ore from the Keystone mine contains galena, both as coarse granular masses coated with earthy anglesite, cerusite, and limonite (Cat. No. 30198, U.S.N.M.) and as very fine grained steel galena bordered by ashy anglesite (Cat. No. 60940, U.S.N.M.). One shipment of galena ore was made from the Galena Silver mine in 1917.

Galena occurs in silver ores from the Mineral district associated with tetrahedrite, chalcopyrite, pyrite, and sphalerite in a calcite gangue. The Silver Bell, Maria, Black Hawk, and Eagan are the principal mines. In the Maria the galena, which is not very abundant, is intimately intergrown with the sphalerite in concentric rings.[69]

In the Seven Devils district galena is present as a rarity in all of the contact-metamorphic copper deposits and also sparingly in the low grade disseminated "porphyry" copper ore of the Red Ledge mine.[70]

NAUMANNITE (48)

Silver selenide, Ag_2Se. Isometric.

Naumannite, a comparatively rare silver mineral, is known to occur in Owyhee County; and a selenide, most probably naumannite, is of rather frequent occurrence in gold-silver ores of late Tertiary age in Custer and Lemhi Counties. The mineral differs from argentite or silver glance only in containing selenium instead of sulphur and in its general physical properties it is very similar to argentite so that other occurrences of "silver glance" in the State may prove to be naumannite. The tests for selenium are distinctive and easily applied. When heated in the flame the mineral gives a characteristic odor, described in the textbooks as like that of "decaying horseradish" and colors the flame blue. Heated in the closed tube it gives a characteristic red and black sublimate of selenium. Selenium seems to be confined to, and characteristic of, late Tertiary veins in volcanic rocks.

CUSTER COUNTY

In the Yankee Fork district in all of the silver-gold ores the richest ore is characterized by blue-black submetallic bands and blotches in which pyrite and tetrahedrite and rarely chalcopyrite may be recognized with the aid of the microscope but the predominant mineral shows as blue-black specks too small to be identified. Partial analyses of two specimens of this material have been made by R. C.

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[69] Waldemar Lindgren. U. S. Geol. Survey, 22d Ann. Rept., p. 755, pt. 2, 1901.

[70] D. C. Livingston and F. B. Laney. Idaho Bur. Mines and Geol. Bull. 1, 1920.

Wells. A specimen from the Montana mine showed gold, selenium, lead, a little bismuth, and a trace of copper. A specimen from the dump of the Lucky Boy mine showed gold, selenium, lead, some copper, and a trace of bismuth. Tellurium was absent from both samples. The definite amount of selenium in both of these ores, the only ones analyzed for it, suggests the presence of some selenide; and this is most probably naumannite. The gangue of these veins is fine grained quartz with some opal and chalcedony and, occasionally calcite. Some of the calcite is lamellar and much of the quartz has a lamellar pseudomorphous structure, while adularia occurs in microscopic grains. The ore minerals are arranged in blue-black bands parallel to the crustification of the vein.[71]

LEMHI COUNTY

In the Gravel Range district rich ores containing gold and silver are characterized by microscopic grains of a blue black mineral in a fine grained quartz gangue containing adularia. A specimen of rich ore of this type from the Monument mine, tested by Doctor Schaller, gave a strong reaction for selenium, which suggests that the dark mineral is naumannite.

The Parker Mountain district contains ores of very similar appearance and of the same age and character, so that the occurrence of selenides in them is to be expected, although no tests have been made.[72]

OWYHEE COUNTY

A specimen of naumannite from the De Lamar mine has been described in detail, this being the first authentic occurrence of this rare silver mineral in the United States.[73] The specimen (Cat. No. 76052, U.S.N.M.) was collected by George H. Eldridge in 1893 from the silver stopes of the De Lamar mine, at De Lamar in the Silver City district. This mine was noted for its large bodies of rich ore which in part occurred as a white to gray or bluish clay filling fissures, and which contained large amounts of a silver mineral in grains, shot or larger masses. This silver mineral, which was malleable and sectile, was commonly supposed to be argentite. The specimen which was found to be naumannite was collected as a typical "nodule of argentite" occurring in the clay, and it is quite possible that the silver in a large part of such ore was in the form of the selenide rather than the sulphide.

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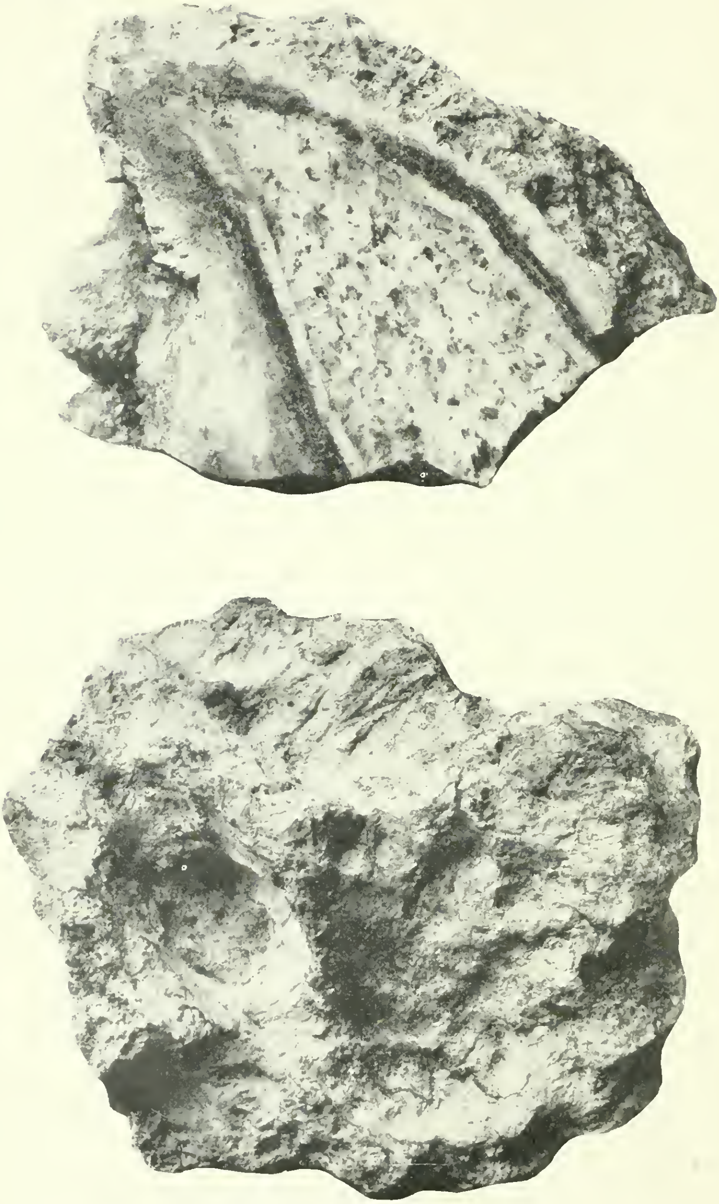
[71] J. B. Umpleby. Some ore deposits of northwestern Custer County, Idaho. U. S. Geol. Survey Bull. 539, pp. 45–47, 1913.

[72] J. B. Umpleby. Geology and ore deposits of Lemhi County, Idaho. U. S. Geol. Survey Bull. 528, pp. 79 and 175, 1913.

[73] Earl V. Shannon. Naumannite from Idaho. Proc. U. S. National Museum, vol. 58, pp. 604–607, 1920. An occurrence of naumannite in Idaho. Amer. Journ. Sci., vol. 50, pp. 390–391, 1920.



ARGENTITE AND NAUMANNITE

FOR DESCRIPTION OF PLATE SEE PAGES 86 AND 103

The specimen of naumannite is an irregularly rectangular flat nodule about 10 by 7 by 3 centimeters in maximum diameters and weighs about 475 grams (1 pound). Little of the metallic mineral is visible on the exterior of the nodule which is completely coated with a thin tenacious layer of grayish clay (pl. 1, lower). The interior of the specimen is composed of the heavy metallic mineral which is so malleable that projecting corners are broken from it with difficulty. In color it is dark blue-gray with metallic luster and faintly shining gray streak. Where broken the fracture is hackly and irregular with no indication of the cubic cleavage which is reported for naumannite. The color is lighter gray than that of argentite and the mineral does not tarnish readily. The hardness is about 2.5 and the specific gravity determined on a sample not entirely free from clay is 6.527. The pure mineral does not reach a specific gravity of 7, suggesting the erroneousness of the value 8 given in textbooks. The descriptions of naumannite from previously reported localities do not emphasize the extremely marked sectility and malleability of the mineral.

Aside from the clay, which coats the exterior of the specimen and is irregularly distributed through the mass, the only impurity is marcasite, which is seen to be distributed in small grains through the naumannite when polished sections are examined with the metallographic microscope in reflected light. The analyzed sample contained 0.90 per cent of iron, all of which was probably present as marcasite. The results of the analysis, recalculated after deducting clay and marcasite gave the following results:

Analysis of naumannite

	Per cent
Silver	75. 98
Selenium	22. 92
Sulphur	1. 10
Total	100. 00

The mineral thus agrees well with the formula given for naumannite, the presence of a little sulphur replacing selenium being interesting as indicating an isomorphous gradation toward argentite. The ratio of selenium to sulphur is so great (17 : 2) that the mineral must be designated naumannite Ag_2Se, rather than aguilarite, to which is ascribed the formula $Ag_2S.Ag_2Se$, that is, the sulphur and selenium are supposedly present in molecularly equal amounts. Lead, copper, gold, zinc, arsenic, antimony, bismuth, and tellurium were proven absent.

The mineral is insoluble in hot concentrated or dilute hydrochloric acid and sulphuric acid but dissolves readily in hot concentrated nitric acid. Heated before the blowpipe on charcoal it yields selenium immediately, with the production of the characteristic odor, and colors the flame blue, leaving behind a large mass of malleable silver. In the closed tube it gives odors of sulphur and selenium, and yields a series of sublimates in rings which grade from yellow (sulphur) at the top, through red (selen-sulphur), to deep red and black (selenium). In the open tube there are obtained odors of sulphur and especially selenium, and a white ring of volatile crystals of selenous oxide which is faintly red in its lower portion from the presence of unoxidized selenium.

Many tons of such ore as that from which the above described specimen came were mined, and the silver mineral was passed by as argentite. It is not improbable that silver selenide has been similarly overlooked in other western silver ores, although the distinctive reactions of selenium are so easily recognized that it is the work of but a moment to prove its presence or absence.

CLAUSTHALITE (47)

Lead selenide, PbSe. Isometric.

SHOSHONE COUNTY

The rare mineral clausthalite has been reported to occur in the Hypotheek mine, near Kingston in the western edge of the Coeur d'Alene district.[74] Nothing is known to the writer regarding the mode of occurrence or associations of the mineral nor have any specimens been seen.

CHALCOCITE (54)

Cuprous sulphide, Cu_2S. Orthorhombic.

Chalcocite, commonly known as copper glance, is a comparatively uncommon mineral in Idaho and no bodies of important size are known. It has been recognized in small amounts at the following localities:

ADAMS COUNTY

In the Seven Devils district chalcocite is always secondary and occurs only sparingly as a replacement of chalcopyrite or bornite in the contact copper deposits. In the Badger mine the ore consists of chalcocite with tetrahedrite and bornite in a 15 cm. vein of quartz. South of the Badger claim this mineral occurs in fractures and replacements in andesite. At the Wilford mine chalcocite is sparingly disseminated through andesite. At the 1905 mine it occurs in silicified andesite with bornite and tetrahedrite and their oxidation products. In the Lucky Strike (Walter James) prospect chalcocite is found sparingly with bornite along fractures in chalcopyrite which it replaces and it occurs similarly replacing bornite and chalcopyrite in the Panama Pacific and Gaarden mine. In the disseminated deposit of the Red Ledge mine the best ore has been enriched by the replacement of chalcopyrite and especially galena by chalcocite.[75] Specimens of ore from the Fidelity Group show rather abundant chalcocite partly altered to chrysocolla and malachite.

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[74] Ernest Leroy Adkins. Personal letter, 1917.

CUSTER COUNTY

In the Mackay district chalcocite is very rare in the copper ores. It occurs only in small amounts as thin films along fracture planes and as minute specks imbedded in chrysocolla in the oxidized ores.[76] In northwestern Custer County copper glance is found locally as films along cracks in the upper level of the Lost Packer mine and is probably also present in the upper levels of the silver-copper deposits.[77]

BANNOCK COUNTY

Judging from specimens in the National Museum, the best and most typical chalcocite from any locality in the State is from the Moonlight mine of the Pocatello Gold and Copper Co., on Rabbit Creek, 9 miles east of Pocatello in the Fort Hall district. The specimens (Cat. No. 75521, U.S.N.M.) show clean gray lustrous masses of chalcocite in an indeterminate chalky white rock. The chalcocite is in considerable part altered to brochantite. As described by Weeks and Heikes [78] the chalcocite occurs with bornite in small kidney-shaped masses and seams along fractures and fissures in conglomerate.

LEMHI COUNTY

In Lemhi County chalcocite, though nowhere abundant, can generally be found a short distance below the surface in the copper bearing deposits.[79]

SHOSHONE COUNTY

In Shoshone County chalcocite occurs in the Snowstorm, National, Park, Reindeer, Carney Copper, and probably other copper mines and prospects in the vicinity of Mullan. At the Snowstorm mine it occurred with bornite disseminated through quartzite and occasionally concentrated in bunches in small quartz veins which cut the disseminated deposits. At the Park mine, 4 miles south of Mullan, the chalcocite, which has apparently been formed by the action of descending sulphate waters on pyrite and chalcopyrite, occupied a vein near the bottom of the zone of oxidation.[80]

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[75] D. C. Livingston and F. B. Laney. The copper deposits of the Seven Devils and adjacent districts Idaho Bur. Mines and Geol. Bull. 1, 1920.

[76] J. B. Umpleby. U. S. Geol. Survey, Prof. Paper 97, p. 50, 1917.

[77] J. B. Umpleby. U. S. Geol. Survey Bull. 539, p. 52, 1913.

[78] F. B. Weeks and V. C. Heikes. Notes on the Fort Hall Mining district, Idaho. U. S. Geol. Survey Bull. 340, p. 180, 1908.

[79] J. B. Umpleby. U. S. Geol. Survey Bull. 528, p. 76, 1913.

[80] F. L. Ransome. U. S. Geol. Survey, Prof. Paper 62, p. 91, 1908.

STROMEYERITE (55)

Silver-copper sulphide, $Ag_2S.Cu_2S$. Orthorhombic.

The occurrence of stromeyerite in the State has in no case been definitely established. Sectile grains of a mineral resembling argentite but assuming a bluish tarnish upon exposure which react qualitatively for silver, sulphur, and copper occur frequently in rich silver ores and are probably stromeyerite.

ELMORE COUNTY

Some of the richest ore from the Atlanta mine, Atlanta district (Cat. No. 30199, U.S.N.M.), composed of large masses of granular pyrargyrite and stephanite contains disseminated blue-tarnishing grains of this supposed stromeyerite associated with dull mossy black argentite.

OWYHEE COUNTY

In ore from the Rising Star mine soft gray grains up to 3 millimeters in diameter become deep blue upon exposure. These grains, which are probably stromeyerite, are disseminated in quartz with stibnite, stephanite, argentite, and polybasite.

SHOSHONE COUNTY

A single specimen of very rich silver ore from the Caledonia mine, Coeur d'Alene district, consists of white quartzite fragments cemented by a dark gray sectile mineral which tarnishes to a purple color. This gray mineral, which contained disseminated grains of chalcopyrite, showed on analysis silver, copper, and sulphur, and was no doubt stromeyerite.

SPHALERITE (58)

Zinc sulphide, ZnS. Isometric, tetrahedral.

Sphalerite, the sulphide of zinc, is a very common mineral, being the only important ore of zinc in Idaho and also occurring, like galena and pyrite, in numerous veins as an accessory. This mineral, which is almost always massive with coarse to fine granular structure, passes in many places under quite a variety of names, such as zincblende, black jack, rosin jack, etc. These names are not so commonly applied in Idaho where the prevailing type of sphalerite is very dark brown and is known simply as "zinc." The mineral varies in color however, from nearly white through various shades of yellow and amber or occasionally green to dark brown and black, the latter color being due to some iron being present in isomorphous form. In a majority of cases the sphalerite is a more or less valueless and troublesome constituent of the ores, although in recent years the mineral has been marketed in large amounts, especially from the Coeur d'Alene region. Here it usually occurs mixed with galena from which it is separated in milling mainly by the process of differential flotation. Some mines contain much more zinc than lead and can make a clean crude ore product consisting almost entirely of sphalerite. The principal types of occurrences are listed below.

ADA COUNTY

Sphalerite occurs in the gold ores of the Black Hornet and Boise districts. Specimens from the Black Hornet mine show heavy masses of sulphides from streaks along the borders of a large quartz vein. These sulphide streaks yield hand specimens of practically pure coarse granular cleavable black auriferous sphalerite.

BLAINE COUNTY

In the Mineral Hill (Hailey, Wood River district) sphalerite is common in the lead-silver veins both in slate and in granite and also in the gold veins in granite. In the lead ores it is usually an inconspicuous mineral present in amounts too small to be a serious nuisance and very few of the mines have enough sphalerite to make a zinc product. In a few mines, notably the North Star on the east fork of Wood River, the sphalerite is abundant mixed with the galena and other sulphides. The sphalerite of this district is usually massive, fairly coarse grained and dark brown in color.

In the Rosetta district sphalerite is common in the ores. Specimens from the Dollarhide mine show resinous dark brown sphalerite in quartz with galena and arsenopyrite. Ore from the Golden Glow mine contains pure granular masses of sphalerite and very fine grained grayish sphalerite intergrown with galena and boulangerite. A large specimen from the New Hope (Warfield) property contains very fine grained massive black sphalerite with fine grained galena. A specimen labeled Neptune mine, Blaine County (Cat. No. 56536, U.S.N.M.) shows golden yellow and dark brown grains of sphalerite with pyrite in a gangue of quartz and rhodochrosite in a silver ore.

BOISE COUNTY

In the Banner district sphalerite occurs in coarse grains of a rich brown color intimately associated with pyrargyrite and stephanite in the richer streaks of the silver ores of the Banner mine.

In the Quartzburg (Idaho Basin) district sphalerite is a common constituent of the gold ores below the oxidized zone. Ore from the Mountain Chief mine shows coarse brilliant granular dark brown to black sphalerite intergrown with chalcopyrite and pyrite in a quartz gangue. Specimens from the lower tunnel of the Carroll-Driscoll group show masses of dark brown sphalerite up to several centimeters across in a gangue of white quartz with a little chalcopyrite and tetrahedrite. The sphalerite is blue on fractures and on polished cross section is seen to be largely replaced along cracks and seams by covellite, as is also the associated chalcopyrite. Another specimen of ore washed from a sericitic gouge shows nearly colorless to yellow and brown crystals of sphalerite in quartz with tetrahedrite and a little purplish barite. Ore from the Native Missourian No. 2 claim contains very dark brown fine massive sphalerite intergrown with pyrite in quartz and resinous dark brown sphalerite occurs with pyrite and chalcopyrite forming heavy masses of sulphides in quartz.

In the Summit Flat (Pioneerville) district the occurrence of sphalerite is in gold veins similar to the last. Ore from the Enterprise vein, Blackbird tunnel shows granular brilliant black sphalerite with pyrite in sericitized granite.

In the Ingle Group claims sphalerite of the usual dark brown massive type is the most abundant mineral in heavy masses of auriferous sulphides several centimeters in diameter in quartz. Specimens from the Fairmont claim show black sphalerite with a pinkish carbonate in thin seams in granite. Fine brown sphalerite in masses in quartz from the stope between the upper and lower levels of the Mohawk mine is largely fractured and slightly separated, the space between the fragments being filled by later quartz. This sphalerite is blue on fracture and on polished surfaces is found to be replaced along cracks and seams by covellite like that from the Carroll-Driscoll mine mentioned above. Considerable masses of granular brown sphalerite with less galena and pyrite occur in quartz in ore from the Pool Group, Diana Mines Co.; and black sphalerite with much pyrite and a little galena makes up masses of sulphides replacing altered granite in the Golden Age mine, occurring in this mine also in crystalline grains disseminated in crushed quartz with pyrite, galena, and tetrahedrite. Gold ore from the Overlook mine contains coarse black sphalerite intergrown with galena, pyrite, and tetrahedrite in quartz.

In the Pearl district sphalerite occurs as an auriferous sulphide in gold ores as in the Checkmate mine where zinc sulphide of the usual very dark brown color intergrown with galena and pyrite forms seams 1.5 cm. wide in altered granite containing disseminated minute crystals of arsenopyrite, as heavy masses intergrown with arsenopyrite and as segregated masses. The best sulphide gold ore from the Lincoln mine in hand sized specimens shows mainly coarsely crystalline sphalerite of dark brown color associated with some silvery sericite. Porous cavities in the massive granular sphalerite contain small crystals of sphalerite exhibiting positive and negative tetrahedra, associated with pyritohedral crystals of pyrite. Other specimens from the Black Pearl mine contain sphalerite intergrown with much pyrite and some galena as heavy masses of auriferous sulphides in sericitized granite; and those from the Granite State mine contain resinous dark brown sphalerite as the most prominent sulphide in a 6 cm. vein of auriferous quartz-sulphide ore cutting granite.

BONNER COUNTY

Sphalerite is found in moderate amount associated with galena in lead-silver prospects and small mines in a number of places in Bonner County. Only a small number of specimens have been available for examination, and few of the ores have previously been described in detail. No important production of zinc ore has been made and, so far as known, the occurrences of sphalerite in this county show no features of especial mineralogic interest.

CUSTER COUNTY

In the Bay Horse district sphalerite is present in very subordinate amount in the primary ore of the lead-silver deposits. By its oxidation it has given rise to some calamine and smithsonite. In the East Fork (Copper Basin) district the existence of sphalerite in the primary ore of the Starr Hope mine is indicated by the presence of smithsonite in the oxidized ore. Near the head of the Middle Fork of Lost River the ore of the Phi Kappa prospect in Phi Kappa Canyon contains granular sphalerite with galena and chalcopyrite in granular garnet rock. Some sphalerite occurs also in a prospect near the head of Little Fall Creek.

In the Seafoam district a little sphalerite occurs with other sulphides as impregnations in granite along fissures in the Bulldog and other claims. In the Sheep Mountain district sphalerite is found in considerable amount in lead-silver ores of the Golconda, King, and other properties.

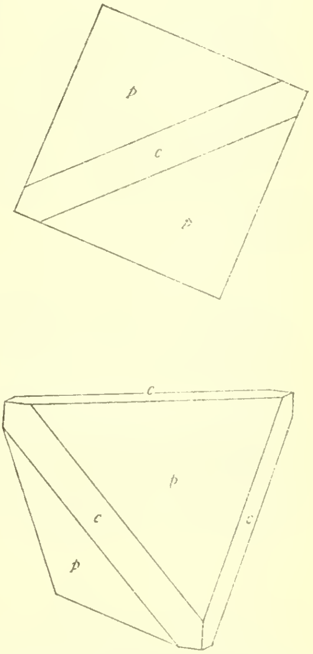

Fig. 6.—Sphalerite crystal, showing positive tetrahedron beveled by narrow faces of the cube. Empire mine, Washington Basin district, Custer County

In the Washington Basin district sphalerite occurs with pyrrhotite, arsenopyrite, etc., in vein matter from the Empire group. A specimen from the upper tunnel of the Empire shows considerable masses of sphalerite in quartz. This material has a peculiar appearance and has been mistaken for hubnerite. Specimens from a winze in the lower tunnel of the Empire show coarse brilliant dark brown sphalerite in quartz with galena and arsenopyrite. Small vugs contain bright crystals, one of which was measured and found to be bounded by faces of the cube and plus tetrahedron. This crystal is figured as Figure 6.

ELMORE COUNTY

In the Neal district a little sphalerite occurs with pyrite and galena in the primary ore of the gold veins. A sample of clean sphalerite yielded 1.4 ounces gold a ton on assay.[81] In the Pine Grove and Rocky Bar districts sphalerite is of similar scattered occurrence in the primary ore of the sulphide-bearing gold veins.

IDAHO COUNTY

Sphalerite occurs in a large number of mining districts in Idaho County, but mainly only as scattered grains in gold quartz ores. A typical specimen of ore from the Mallard Creek property of W. Sendke in the Dixie district shows sphalerite as sparse light brown grains with galena in quartz; and one from the Black Pine mine, Elk City district, has cleavable grains of dark brown sphalerite disseminated in quartz with galena, pyrite, tetrahedrite, and free gold.

LEMHI COUNTY

Sphalerite is widespread in occurrence in the various mining districts of Lemhi County, but nowhere in sufficient amount to constitute an ore of zinc. As much as 10 per cent of zinc, probably mostly in the form of secondary minerals derived from sphalerite, appears in some of the lead-silver deposits. In the ores of the Blue Wing district black sphalerite is commonly associated with hubnerite, with which it is likely to be confused. Its characteristic light gray streak, however, serves to identify it.

OWYHEE COUNTY

In the Silver City, De Lamar, and Flint districts sphalerite occurs in the silver ores, usually as sparse grains in comb quartz with rich silver-bearing sulphides. A specimen labeled as from the Banner mine, Silver City district, contains sphalerite in masses up to 1 centimeter in diameter with chalcopyrite disseminated in white quartz. This sphalerite, which shows good cleavage, is light gray in color, almost as white as the Franklin furnace cleiophane, and has a white streak. A specimen of sulphide gold ore from the Bergh mine, 11 miles north of De Lamar, consists of coarse black sphalerite intergrown with galena and pyrrhotite. In the South Mountain district sphalerite is common in the ores associated with galena and other sulphides. A specimen from the Bay State mine shows very black sphalerite intergrown with arsenopyrite.

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[81] Waldemar Lindgren. U. S. Geol. Survey, 18th Ann. Rept., pt. 3, p. 702, 1896.

SHOSHONE COUNTY

Shoshone County contains large amounts of sphalerite. This occurs as a constituent of the ores of the veins which have been mined for lead and silver, although the proportion of sphalerite in the ore varies markedly from vein to vein, some mines containing very little zinc associated with the galena, and there are a large number in which the zinc sulphide nearly equals galena in amount and a few in which sphalerite is the most abundant mineral and galena is subordinate. The production of zinc in 1916 from this region is reported as over 86,000,000 pounds of metal, or about one-fourth as much zinc as lead.

The sphalerite is practically all massive and of a dark brown color and resinous luster. The size of grain varies but is usually similar to that of the associated galena. In the Amy Matchless claims on Pine Creek a few reddish crystals occur in minute vugs, several ruby red crystals of small size occurred in a crack in ore from the 1,600-foot level of the Greenhill-Cleveland mine at Mace and a few honey yellow tetrahedral crystals were noted in a specimen from the Temby stope of the Bunker Hill mine. These constitute the only known free crystals from the district. The color of the mineral in the Coeur d'Alene region is chiefly a uniform dark brown, although coarser reddish-brown material has come from the Success mine, a little honey yellow of coarse grain has been found on the No. 13 level of the Bunker Hill mine, and a peculiar gray fine-grained sphalerite occurs in some quantity associated with similar galena in calcite and quartz in ore from the Hamburg-American claim on Little North Fork of Coeur d'Alene River.

The mines along Canyon Creek contain variable amounts of sphalerite. It is common in the Hercules but occurs for the most part in segregated bunches. The Hecla vein is relatively free from sphalerite. In the Marsh and the now abandoned Tiger-Poorman, Standard-Mammoth, and Greenhill-Cleveland veins the sphalerite was relatively unimportant in the upper levels but seemed to become increasingly abundant with depth. The Frisco ore body contains much sphalerite.

Near Mullan sphalerite is a more or less constant accessory in the Gold Hunter ore and is abundant in the Morning mine while in the adjoining Star property the ore consists of an intimate intergrowth of galena and sphalerite.

On Ninemile the deposits are for the most part essentially zinc mines, galena being very subordinate. The Success (Granite) has mined a very irregular mass of sphalerite ore containing the sphalerite in association with garnet, mica, chlorite, and other contact metamorphic silicates, at the contact of an intrusive mass of quartz monzonite against the inclosing slates. The Interstate-Callahan, one of the most productive zinc mines in the world, has a large vein deposit of high-grade sphalerite containing a very subordinate amount of galena. When visited by the writer in 1914 this mine had exposed on one level a body of nearly pure sphalerite ore 400 meters (1,200 feet) in length and in places reaching a width of 5 meters (18 feet). Other zinc mines in this section are the Clarke (Sunset), and Rex (16 to 1).

The mines near Wardner contain very little sphalerite, the Bunker Hill making no zinc product while the Caledonia, Sierra Nevada, Ontario, and other veins of the group contain almost no sphalerite.

The Pine Creek district contains a large number of sphalerite bearing veins from some of which considerable zinc has been produced. Many of these carry, in addition to the galena and sphalerite, much pyrite, pyrrhotite, and some chalcopyrite. Some of these ores are characterized by a contemporaneous intergrowth of sphalerite and galena which is so exceedingly fine that neither mineral can be detected with a lens.

Some veins of the North Side district, on tributaries of Prichard Creek, contain considerable amounts of sphalerite, as, for example the Granite-Allie, Cedar Creek, Monarch, Paragon, Terrible Edith, and others.

In general the sphalerite of the Coeur d'Alene district is poor in silver and characterizes silver-poor ores.

WASHINGTON AND ADAMS COUNTIES

A specimen of typical ore from the Azurite mine shows almost white (cleiophane) sphalerite in massive form with galena and tetrahedrite in white quartz.

METACINNABARITE (59)

Mercuric sulphide, HgS. Isometric.

Metacinnabarite has been identified only in one locality in Idaho and that is in Blaine County.

BLAINE COUNTY

A specimen of cinnabar collected by C. P. Ross from the Dockwell tunnel near the head of Deer Creek in the Hailey district consists of drusy crusts of minute indistinct cinnabar crystals lining open spaces. Resting on the cinnabar are a few perfectly spherical smooth and lustrous globules of black color 1 millimeter or less in diameter. These, when crushed and examined under the microscope, are perfectly opaque and black with a metallic luster. Heated over a flame they volatilize leaving a little white gangue surrounded by a yellow halo on a slide glass. The mineral is doubtless metacinnabarite.

CINNABAR (66)

Mercury sulphide, HgS. Trigonal, trapezohedral.

Cinnabar is the common ore mineral of mercury. It has been noted in small amounts in a number of localities in Idaho and some rather extensive development has been done upon the properties of a few districts. Thus far the ore found has been relatively low grade and large masses of pure cinnabar of even specimen size have rarely been found. The principal localities regarding which definite information is available are mentioned below.

BOISE COUNTY

A heavy concentrate from placer gravels from the Idaho City dredge, Idaho City, contains rare grains of cinnabar associated with samarskite, columbite, and other heavy minerals. No cinnabar has been found in place in this district and the source of the mineral in the placers is not known. Fragments of cinnabar occur in the gravels of the Church placer mine in Marsh Valley and are found in the sluice boxes, used for concentrating the gold. It is said to have been found in place in small seams in the granite of the vicinity.[82]

CASSIA COUNTY

Cinnabar occurs in claims of the Valentine Cinnabar Co., 4½ miles west of Black Pine post office in Cassia County. The deposit is at the top of a limestone bed below shale and was formed by replacement of the limestone. The material is mineralized and friable and is made up mainly of barite and quartz. Tabular crystals of barite project into cavities. The cinnabar forms a very thin sooty or dustlike coating, imparting a red color to the rock but forming only a very low grade ore. The red material contains a little arsenic and is probably a mixture of cinnabar and realgar. Near the surface there is much scorodite in leek green botryoidal fibrous crusts coating the quartz and barite. Some of the cinnabar of this locality seems to be entirely amorphous. The deposit is probably the result of fairly recent hot spring activity.[83]

CLEARWATER COUNTY

Cinnabar has been noted in placer concentrates from several localities in the Pierce district, although none has been found in place in the region. One coarse sample (Cat. No. 87506, U.S.N.M.) shows grains of massive cinnabar up to 1.5 cm. in diameter in a concentrate from Pierce associated with rutile, corundum, epidote, tourmaline, etc. Another finer sand shows grains of clear red cinnabar with monazite, ilmenite, gold, etc. Pebbles of cinnabar from near Resort are sometimes over 2 cm. in diameter.

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[82] Waldemar Lingren. U. S. Geol. Survey, Folio 45, 1898.

[83] Esper S. Larsen. Univ. of Idaho, Sch. of Mines. Bull. 2, pp. 65–67, 1921.

CUSTER COUNTY

Cinnabar is found in some quantity in the gravels worked by the Willis dredge in Stanley Basin, where it is associated with gold and native amalgam. The cinnabar is becoming more abundant as the dredge is moved upstream.[84] A sample of pan concentrate from this placer sent to the National Museum by H. C. Willis consists in the main of a heavy radioactive mineral, possibly brannerite, with small grains of clear red crystalline cinnabar and occasional grains of monazite, zircon, and amalgam.

VALLEY COUNTY

Economically the most promising cinnabar deposits yet opened in Idaho are those of the Yellow Pine district in Valley County. These appear to have been formed by replacement of marble and to be mostly near the contacts of marble with quartzite and schists. There is little evidence of continuous veins but the deposits are rather in the form of irregular or lenticular bodies such as are common in replacement deposits in the limestone. In some places the silica forms a network of anastomosing veinlets in the marble, in others it completely replaces the marble. Cinnabar is the only sulphide in most of the ore, although considerable pyrite, more or less altered, is present in some parts of the deposits, and stibnite is associated with cinnabar on the ridge just north of the Fern mine. The cinnabar is rather coarsely crystalline and most of it is in the cherty silica, but some is in a friable sandy marble near the silica zones and a little is disseminated in the hard white marble.

A considerable part of the ore treated at the Fern mine came from material partly filling a cave in the marble and was made up of blocks of hard ore embedded in a silica-rich sand. The antimony deposits in the granodiorite just south of the cinnabar deposits carry a little cinnabar and the two are probably related in origin. The principal mercury claims are the Fern, Yellow Pine, Idaho, Abstein, and Monumental groups. The production of the Fern Co. up to August, 1918, was largely derived from float and from the cave deposit.[85]

COVELLITE (67)

Cupric sulphide, CuS. Hexagonal.

BOISE COUNTY

Coarse sphalerite from sulphidic gold ores of several mines in the Summit Flat and Centerville districts is characterized by a peculiar deep indigo blue color of all fractures, although yielding the characteristic brown streak of sphalerite. Polished cross sections show that the blue color is due to partial replacement of the sphalerite by covellite along all seams and fractures, the material varying from very thin films to almost complete replacements. Such covellite was seen in specimens from the stope between the upper levels of the Mohawk mine and from the Coon Dog No. 1 mine, Summit Flat district and also from the lower tunnel of the Carroll-Driscoll group, Quartzburg district. In the latter specimen the associated chalcopyrite is also similarly replaced by covellite.

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[84] J. B. Umpleby and D. C. Livingston. Idaho State Bur. Mines & Geology, Bull. 3, p. 16, 1920.

[85] E. S. Larsen and D. C. Livingston. Geology of the Yellow Pine quicksilver mining district, Idaho U. S. Geol. Survey Bull. 715, pp. 73-83, 1920.

CUSTER COUNTY

Covellite occurs as indigo blue films on other sulphides in various parts of the Empire mine at Mackay. Some very fine specimens of this mineral from the Hearst tunnel, a small tunnel west of the dump of the 300-foot tunnel of the Empire mine consist of fine blue covellite mixed with chalcopyrite, the covellite forming about 60 per cent of the masses. Polished surfaces show the two minerals to form a very beautiful intergrowth of plates which has been interpreted as originating through the replacement of the chalcopyrite by the covellite along cleavage lines. It is, however, possible that the two minerals have deposited simultaneously in graphic intergrowth.

LEMHI COUNTY

Covellite has been noted in specimens from the Blackbird district. It occurs as beautiful indigo crusts surrounding cores of chalcopyrite which are in turn surrounded by iron oxide.[86]

SHOSHONE COUNTY

Sooty covellite has been observed in several mines in the Coeur d' Alene district. In a stope above the first level of the Last Chance mine at Wardner some rich oxidized ore was accompanied by streaks of soft black sooty material. The deep indigo color of freshly broken lumps and characteristic blowpipe reactions proved this to be covellite. Most of the lumps inclosed small specks of chalcopyrite showing this, perhaps with some tetrahedrite, to be the original mineral from which the covellite was derived in the process of general oxidation.[87] In the Caledonia mine covellite was common near the base of the oxidized zone as a deep blue to black powder in cavities and as compact lusterless masses. The mineral seemed in most cases to replace galena and masses of galena were commonly incrusted with layers of covellite 2 to 10 centimeters thick. This covellite was deep indigo blue on fresh fracture but became dull black on short exposure. It contained disseminated masses of pyrite and glassy anglesite and was rather highly argentiferous. In the Hypotheek mine at Kingston covellite occurs in oxidized ore associated with cerusite, bindheimite, etc., as pulverulent dark blue fillings of cavities. In the Liberal King and probably other veins a part of the sphalerite is blue from covellite developed along seams.

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[86] J. B. Umpleby. U. S. Geol. Survey, Bull. 528, p. 76, 1913.
[87] F. L. Ransome. U. S. Geol. Survey, Prof. Paper 62, p. 92, 1908.

WASHINGTON AND ADAMS COUNTIES

In the Seven Devils district covellite is found sparingly as a product of downward secondary enrichment replacing chalcopyrite and bornite along fractures in the contact copper deposits. It occurs in small amount with chalcocite along fractures in chalcopyrite in fissure quartz-feldspar veins in granite at the Lucky Strike mine, replacing chalcopyrite at the Gaarden mine, or chalcopyrite and bornite at the River Queen mine.

GREENOCKITE (68)

Cadmium sulphide, CdS. Hexagonal, hemimorphic.

BLAINE COUNTY

Greenockite has been doubtfully identified as a yellow coating on oxidized ore in the Plughof, formerly the Lark mine, 2 miles southwest of Bellevue.[87a]

WURTZITE (69)

Zinc sulphide, ZnS. Hexagonal, hemimorphic.

BLAINE COUNTY

Wurtzite, the rare hexagonal form of zinc sulphide, occurs with sphalerite in a group of late Tertiary veins in the Lava Creek and Era districts in Blaine County, especially in the St. Louis mine in the latter district. The gangue of these veins consists of cryptocrystalline quartz and chalcedony with, in places, some calcite and barite. The ore minerals comprise galena, sphalerite, wurtzite, pyrite, chalcopyrite, proustite, tetrahedrite, and argentite. These occur in veins and, to some extent, replacing the wall rocks. Cerargyrite, smithsonite, and cerusite are secondary minerals. In the wall rocks sphalerite, pyrite, and wurtzite replace the minerals of the inclosing lavas and tuffs. The sphalerite and wurtzite are, for the most part, fine grained and without crystal outline, but locally the wurtzite occurs in peculiar spherical masses 6 to 15 millimeters in diameter. In cross section these are made up of an outer band of dark brown dense wurtzite separated from a large central light brown area by a dense black layer, also of wurtzite. The inner light brown core is spongy in texture and has a distinctly radial structure, the interstices being filled by calcite. Spherical bodies of wurtzite occur in unaltered galena ore and are traversed by veinlets of galena.[87b]

[87a] D. F. Hewett. Personal communication, 1923.

[87b] J. B. Umpleby. U. S. Geol. Survey, Prof. Paper 97, p. 86, 1917.

NICCOLITE (71)

Nickel arsenide, NiAs. Hexagonal.

LEMHI COUNTY

Niccolite is reported to occur as small indistinct crystals of a pale copper-red color with dark tarnish in ores of the Togo claim in the Blackbird district, where it is associated with smaltite and other cobalt-nickel minerals. It is said to alter to annabergite.[88]

PYRRHOTITE (74)

Iron sulphide, Fe_7S_8 to FeS. Hexagonal.

The hexagonal form of iron sulphide commonly known as magnetic pyrite is a fairly common mineral, occurring usually in massive granular form. It may be distinguished from the more common pyrite by its faintly coppery color and the property of being attracted by a magnet. Localities which have been noted are mentioned below.

BLAINE COUNTY

Massive pyrrhotite forms a prominent constituent of the ores of the Croesus, Camas, and Tip Top veins. These are gold veins in granite and much of the ore consists of intergrown auriferous sulhides, including galena, pyrite, pyrrhotite, chalcopyrite, and arsenopyrite.[89] Coarse granular pyrrhotite occurs also in the ore of the Golden Glow and other mines of the Rosetta district, with pyrite and sphalerite in quartz.

CUSTER COUNTY

Pyrrhotite may be extracted in small amount from crushed samples of most of the sulphide ore of the Alder Creek district. The individual grains are so minute that they can be detected only with the aid of a magnet.[90] In the Lost Packer mine in the Loon Creek district pyrrhotite occurs sparingly as small crystals inclosed either in chalcopyrite or in quartz.[91] In the Seafoam district pyrrhotite occurs in a vein in limestone with galena sphalerite and pyrite. About 400 feet west of the Golconda discovery a vein of auriferous pyrrhotite 5 feet wide occurs in limestone. This pyrrhotite assays $14 a ton in gold.[92] In Washington Basin pyrrhotite is the most abundant sulphide of the great sulphidic masses of the Empire ledge.

LATAH COUNTY

In the Hoodoo district in the Mizpah and adjacent prospects pyrrhotite is common in the ores associated with chalcopyrite. It sometimes forms considerable masses, often containing coarse crystals of biotite.[93]

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[88] J. B. Umpleby. U. S. Geol. Survey, Bull. 528, p. 78, 1913.

[89] Waldemar Lindgren. U. S. Geol. Survey, Ann. 20, pt. 3, pp. 207-208, 1900.

[90] J. B. Umpleby. U. S. Geol. Survey, Prof. Paper 97, p. 54, 1917.

[91] J. B. Umpleby. U. S. Geol. Survey, Bull. 539, p. 53, 1913.

[92] J. B. Umpleby and D. C. Livingston. Idaho Bur. Geol. and Mines, Bull. 3, p. 18.

[93] D. C. Livingston and F. B. Laney. Idaho Bur. Mines and Geol., Bull. 1, p. 95, 1920.

LEMHI COUNTY

In Lemhi County pyrrhotite is a common mineral in the cobalt ores of the Blackbird district intergrown with quartz and possibly also as a segregation in diabase. It is all slightly nickeliferous, one specimen from the Togo claim yielding upon analysis 0.8 per cent nickel.[94] A specimen from the Togo claim examined by the writer contained masses of clean glistening pyrrhotite up to 2 centimeters in diameter in quartz. These gave a distinct reaction for nickel with dimethylglyoxime. In the Indian Creek district pyrrhotite occurs as a constituent of gold ores, especially in the Kittie Burton mine, where it is associated with pyrite and quartz.

OWYHEE COUNTY

Pyrrhotite occurs in the form of coarse bronzy grains intergrown with galena and sphalerite in heavy masses of auriferous sulphides from the gold vein of the Bergh mine 11 miles north of De Lamar.

SHOSHONE COUNTY

In the Coeur d' Alene district massive pyrrhotite was abundantly present in the deep level ores of the Standard-Mammoth and Greenhill-Cleveland ore shoots, where it was intergrown with pyrite, siderite sphalerite, and magnetite and galena. It occurred similarly though less abundantly in the Tiger Poorman mine. Masses of granular pyrrhotite up to several inches in diameter occur in the rich galena ores of the Hercules mine and it is present in the Helena-Frisco and Morning mines. East of Kellogg pyrrhotite is very abundant in heavy masses with pyrite and chalcopyrite in a quartz ankerite gangue in many commercially valueless veins in the Prichard formation as the Teddy, Lucky Boy, Wisconsin, Enterprise, Evolution, and other claims. It occurs abundantly in many of the mines on Pine Creek intergrown with other sulphides. In ore from the International mine it occurs in quartz intergrown with contemporaneous pyrite, galena, and sphalerite, all of which replace the quartz along fractures. Specimens from the Nabob mine show large masses of pyrrhotite replacing quartz with a very little galena and chalcopyrite. An interesting specimen from the Sherman mine contains large vitreous masses of pyrrhotite with conchoidal fracture in quartz with ankerite and prochlorite. The pyrrhotite forms films penetrating the coarse ankerite crystals along cleavage planes. Like pyrite pyrrhotite sometimes occurs disseminated in the Prichard formation remote from mineral veins. Pyrrhotite is also a constituent of copper ores in the Monitor, Black Prince, and other mines in the St. Joe Basin.

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[94] J. B. Umpleby. U. S. Geol. Survey Bull. 528, p. 163, 1913.

BORNITE (78)

Copper iron sulphide, $2Cu_2S. CuS. FeS$. Isometric.

Bornite is commonly known as peacock copper and is a relatively high grade copper ore. It is easily distinguished by its unusual colors. On fresh fracture the mineral is coppery or bronze red but it tarnishes quickly to blue or purple with occasionally shades of red and green. In Idaho chalcopyrite, which often is iridescent on fractures, is frequently erroneously called peacock ore. This is the principal ore mineral in the Seven Devils district and occurs in minor amount in a number of other districts.

ADAMS COUNTY

(Including Washington County in part)

Bornite in massive form is the principal primary copper mineral in the Seven Devils copper district where it generally occurs in association with epidote and garnet in contact metamorphic deposits in limestone (Cat. Nos. 51871 and 67391, U.S.N.M.). Upon weathering it alters to chrysocolla and malachite or sometimes to brochantite.[95] The bornite from the contact deposits is argentiferous, carrying 20 ounces of silver a ton.[96] Bornite occurs also as brilliant masses in white quartz veins as in the Great Eastern vein and it forms the principal metallic mineral in a peculiar pegmatitic orthoclase-quartz vein in the Panama Pacific prospect.[97]

BANNOCK COUNTY

Bornite occurs with chalcocite in quartz in fissures in conglomerate in ore of the Moonlight mine of the Pocatello Gold and Copper Mining Co. near Pocatello. In the specimens seen the bornite is in considerable part altered to dull purplish black "copper-pitch."[98]

CUSTER COUNTY

Bornite is rare in the contact metamorphic copper ores of the Mackay district (White Knob), the principal mineral of the unoxidized copper ores here being chalcopyrite as contrasted with the Seven Devils district. Where it does occur bornite is apparently secondary and often forms narrow veinlets along joints and cracks in chalcopyrite.[99] In specimens from the second east drift, 300 level, Empire mine bornite occurs as disseminated grains with chalcopyrite in garnet rock. In another specimen from the adjoining Tiger claim masses of bornite. now largely altered to chrysocolla and copper pitch and a turquoise blue clayey copper silicate, occur with fluorite in garnet rock.

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[95] Charles Palache. Amer. Jour. Sci., vol. 8, pp. 299-302, 1899.

[96] W. H. Melville. U. S. Geol. Survey Bull. 90, p. 34, 1892.

[97] D. C. Livingston and F. B. Laney. Idaho Bur. Mines and Geol., Bull. 1, p. 38, 1920.

[98] F. B. Weeks and V. C. Heikes. U. S. Geol. Survey Bull. 340, p. 180, 1908.

[99] J. B. Umpleby. U. S. Geol. Survey Prof. Paper 97, p. 50, 1917.

KOOTENAI COUNTY

Bornite is found in several prospects in the vicinity of Lake Pend d'Oreille, as, for example in the June Bug claim on the eastern shore where the bornite occurs in a quartz vein with chalcopyrite and specular hematite.

LEMHI COUNTY

Bornite is common in Lemhi County in the ore deposits along the Continental Divide where it comonly accompanies free gold[1] In the Copper Queen mine bornite constitutes an ore of copper and is the most abundant sulphide, clean masses of the mineral occurring in a quartz vein. A specimen of ore from the Halcomb property, Carmen Creek district, contains a peculiar bornite which on tarnished surfaces grows brown scales like those formed on mohawkite and some chalcocite.

SHOSHONE COUNTY

Bornite occurred in the ore formerly worked in the Snowstorm mine as minute grains disseminated in quartzite with chalcocite and chalcopyrite in amount sufficient to constitute a low-grade copper ore. In quartz veins which intersect this disseminated mineralization masses of nearly pure bornite up to 25 kilograms (50 pounds) in weight were ocasionally found. Bornite has also been reported from a number of copper prospects east of Mullan.

WASHINGTON COUNTY

Bornite is said to occur in a number of small vein deposits in the vicinity of Weiser.

CHALCOPYRITE (83)

Copper iron sulphide, CuS.FeS. Tetragonal, Sphenoidal.

Chalcopyrite, commonly known as pyrites of copper, is, like bornite, a double sulphide of copper and iron. It contains relatively much less copper than bornite, however, the copper content of pure chalcopyrite being only 34.5 per cent while bornite, when pure, contains 55.5 per cent. It is consequently a lower grade ore. Although crystals of chalcopyrite are known from a few localities, the common form of the mineral in Idaho is massive or granular or as disseminated grains, scattered through quartz or other gangue or mixed with other sulphides. In a few localities it is mined as a copper ore and it occurs commonly in many mines and prospects as an accessory sulphide of no commercial value. The color of the mineral on fresh fracture is golden yellow, much yellower than pyrite, which it otherwise resembles. Often this mineral assumes a brilliant iridescent tarnish on joints and fractures and for this reason it is often called peacock copper by Idaho miners, although this name belongs rightly to bornite. Like other common minerals this is so widespread in the State that only a part of the occurrences which have been specially noted can be mentioned.

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[1] J. B. Umpleby. U. S. Geol. Survey Bull. 528, p. 75, 1913.

ADAMS COUNTY

(Including Washington County in part)

In the contact metamorphic copper deposits of the Seven Devils district chalcopyrite is abundant in the ore, although subordinate to bornite in all the deposits of this type except the Arkansaw mine in which bornite is but sparingly present and chalcopyrite is the only important ore mineral. Chalcopyrite is the principal primary mineral in peculiar pegmatitic quartz-orthoclase filled veins at the Lucky Strike prospect occasionally intergrown with bornite and partly enriched by replacement by chalcocite and covellite and it occurs similarly, though in small amount, intergrown with bornite in the Panama Pacific mine, where it has developed in hair lines and dots along cleavage lines in bornite. It is the principal ore mineral in the Gaarden mine and is abundant replacing andesite along a fracture zone up to 2 meters wide in the River Queen mine.[2]

BANNOCK COUNTY

In the Fort Hall mine, Fort Hall district, chalcopyrite constitutes an ore of copper. It occurs as granular masses with some pyrite and galena in a gangue of quartz and white calcite forming seams in folded shaly limestone.[3]

BLAINE COUNTY

In Blaine County chalcopyrite occurs in moderate amount in the Argent and Jay Gould and other lead-silver mines of the Hailey or Wood River district. In the gold veins it is a constituent of heavy masses of auriferous sulphides as in the Croesus, Camas, Tip Top, and other mines.

BOISE COUNTY

In Boise County chalcopyrite is a common constituent of the auriferous sulphide masses of the gold veins. Specimens from the Mountain Chief mine, Quartzburg district, contain chalcopyrite intergrown with sphalerite and as bronzy yellow masses in heavy aggregates of auriferous pyrite and arsenopyrite. In ore from the Carroll-Driscoll mine chalcopyrite is accompanied by pyrite, sphalerite, and less tetrahedrite as masses of sulphides in quartz. The chalcopyrite is blue along joints and fractures from replacement by covellite. Small cavities in the ore contain minute blue sphenoidal crystals of chalcopyrite coated by covellite. Massive chalcopyrite is abundant in the Coon Dog No. 1 property in the Summit Flat district, some veins carrying enough of the mineral to form a low grade copper ore. Much of the chalcopyrite here is also blue from incipient replacement by covellite. It is associated with pyrite and sphalerite in quartz.

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[2] D. C. Livingston and F. B. Laney. Idaho Bur. Geol. & Mines Bull. 1, pp. 37-66, 1920.

[3] F. B. Weeks and V. C. Heikes. Notes on the Fort Hall Mining district, Idaho. U. S. Geol. Survey Bull. 340, pp. 175-183, 1908.

CUSTER COUNTY

Chalcopyrite is an important mineral in the Loon Creek district where the ores of the important mines consist of auriferous chalcopyrite in a siderite-quartz gangue. The Lost Packer is the principal mine working this type of ore and has produced $500,000, The chalcopyrite, which is all massive or finely granular, occurs replacing quartz or siderite along seams. It contains from 2½ to 3 ounces of gold a ton and from 6 to 9 ounces of silver. All of the gold is apparently contained in the chalcopyrite.[4]

In the Bayhorse district chalcopyrite commonly accompanies the tetrahedrite-siderite ores of the Ramshorn and other mines. Fine golden yellow bands of chalcopyrite border narrow veins of tetrahedrite from the Ramshorn mine (Cat. No. 56521, U.S.N.M.) and are mixed with tetrahedrite from the Bull of the Woods mine (Cat. No. 56618, U.S.N.M.). In a specimen from the Utah Boy No. 5 tunnel of the Ramshorn mine chalcopyrite occurs in drusy crusts of minute crystals with galena in cavities in siderite-tetrahedrite ore.

In the Alder Creek (White Knob, Mackay) district chalcopyrite is by far the most abundant primary copper mineral in the ores of the contact metamorphic deposits in limestone. It occurs as an interstitial filling in garnet rock and, in a few places, as grains concentrically distributed in garnet crystals. Magnetite and chalcopyrite seldom occur in the same hand specimen and even in an ore shoot where one is abundant the other is scarce. It is intimately associated with pyrite and in some cases completely surrounds garnet crystals.[5]

FREMONT COUNTY

Chalcopyrite occurs in barite with copper pitch and other alteration products in ore from The Weimer Copper mine 2 miles east of Kaufman in the Skull Canyon district. It is probably the principal primary copper mineral of this mine, the ore of which is very largely oxidized.

IDAHO COUNTY

Chalcopyrite is an accessory mineral in gold ores of a number of mining districts. In the Buffalo Hump district the ores of the

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[4] J. B. Umpleby. U. S. Geol. Survey Bull. 539, p. 96, 1913.

[5] J. B. Umpleby. U. S. Geol. Survey Prof. Paper 97, 1913.

Jumbo mine contain it as the principal sulphide, with pyrite and galena scattered through quartz and ore from the Venture claim shows disseminated patches of chalcopyrite partly altered to copper pitch. Auriferous chalcopyrite distributed through white quartz forms the gold ore of the South Fork mine 7 miles southwest of Elk City and it occurs similarly in many of the mines of the area.

LATAH COUNTY

Chalcopyrite is common in the Hoodoo district as disseminated mineralization in a number of prospects and in considerable masses, sometimes 1 meter (3 or 4 feet) wide and 6 meters (20 feet) long, of nearly pure chalcopyrite in the Mizpah mine. It is associated with pyrrhotite and biotite.[5c]

LEMHI COUNTY

Chalcopyrite is a persistent accessory mineral in Lemhi County occurring in all of the mining districts and nearly all of the mines. In places it is associated with gold but usually it is an inconspicuous companion of pyrite. It occurs in very subordinate amounts in the lead silver deposits.[6]

OWYHEE COUNTY

In Owyhee County chalcopyrite is common in small grains sparsely disseminated in the ore of the Black Jack, Trade Dollar, Morning Star, Poorman, and other rich silver mines. In the Black Jack mine most of the gold is contained in chalcopyrite.[7] A typical specimen of ore from a raise 1, 300 feet from the portal of the Blaine tunnel, Silver City district contains chalcopyrite with argentite finely disseminated in an aggregate of quartz and adularia. Chalcopyrite occurs also mixed with other sulphides in unoxidized ore of the South Mountain district as in the Bay State mine, where it is intergrown with arsenopyrite, sphalerite, and a little galena.

SHOSHONE COUNTY

In the Coeur d'Alene district chalcopyrite is widely distributed in the ores being found occasionally in most of the mines. It is the principal ore mineral in copper prospects east of Mullan, where it occurs pure in considerable masses. In the Snowstorm and National mines it forms fine disseminations with chalcocite, etc., in quartzite. Small amounts of the mineral commonly accompany the rich lead-silver ores. It occurrs especially in the Greenhill-Cleveland ore shoot at Mace in Burke Canyon in parallel bands with pyrrhotite constituting the first mineralization of the vein and in pure golden yellow masses with coarse grained galena in streaks which cut the main mass of the vein filling. In the Caledonia it forms irregular grains and masses included in tetrahedrite or replacing siderite and also as larger masses of pure chalcopyrite, sometimes 250 kilograms (500 pounds) in weight.

[5c] D. C. Livingston and F. B. Laney. Idaho Bur. Geol. & Mines, Bull., p. 95, 1920.

[6] J. B. Umpleby. U. S. Geol. Survey Bull. 528, p. 76, 1913.

[7] Waldemar Lindgren. U. S. Geol. Survey, 20th Ann. Rept., pt. 3, 1900.

In certain veins rich in iron sulphides which occur in the Prichard slates near Kellogg chalcopyrite is common as in the Teddy, Lombardy, Wisconsin, Enterprise, and other claims. The gangue here is quartz and ankerite. Over 20 tons of chalcopyrite ore were shipped from the Wisconsin claim some years ago as copper ore.

In the Pine Creek district chalcopyrite is a common constituent of the mixed sulphide lead-zinc ores where it occurs in a quartz and sometimes ankerite gangue. Banded ore from the Highland-Surprise mine contains alternating streaks of chalcopyrite, galena, and sphalerite. In the Shetland claim it is abundant as grains and small masses in quartz with galena and sphalerite and the occurrence in numerous other mines is the same. In the Northern Light, Bobby Anderson, Carbonate, Lookout Mountain, and Hypotheek mines it occurs in isolated and pure masses of moderate size in white quartz.

On the North Fork and Little North Fork of the Coeur d' Alene River chalcopyrite occurs in numerous prospects as the Britt, Handspike, Shuck, Alva Brown, Riverside, Hamburgh-American, and Horst-Powell (Empire). At the latter property a considerable amount of chalcopyrite ore has been mined.

In the St. Joe drainage area chalcopyrite is abundant in a considerable number of prospects, some of which have made a small production of copper ore. It is the only important primary sulphide and occurs mixed with a little pyrite and pyrrhotite in a gangue of quartz and ankerite. The Monitor and Black Prince are the principal mines of this group.

WASHINGTON COUNTY

Chalcopyrite is a constituent of the silver ores mined in the Mineral district around the town of Mineral, where it occurs in veins with tetrahedrite, pyrite, galena, and sphalerite.[8]

SMALTITE (87)

Cobalt diarsenide, $CoAs_2$ Isometric, pyritohedral.

LEMHI COUNTY

Umpleby [9] states that a cobalt arsenide, possibly smaltite, occurs in the cobalt ores of the Blackbird district in grains of microscopic size as a replacement of quartzite and schist, and is perhaps the most abundant cobalt mineral of the district. All specimens of the ores which have been available to the writer for examination have proven to carry cobaltite rather than smaltite, although the latter probably is present.

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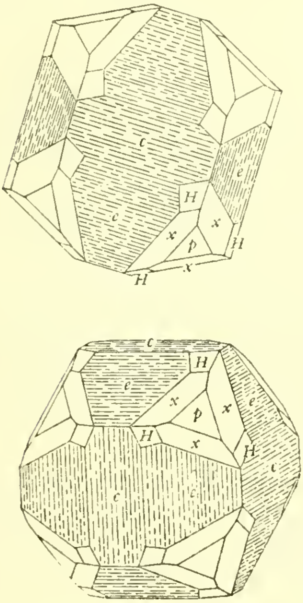
[8] Waldemar Lindgren. U. S. Geol. Survey, 22d Ann. Rept., pt. 2, p. 754, 1901.

[9] J. B. Umpleby. U. S. Geol. Survey, Bull. 528, p. 77, 1913.

PYRITE (85)

Iron disulphide, FeS_2 Isometric, pyritohedral

Pyrite, commonly known to the miners as pyrites of iron, is the most common and widely distributed metallic sulphide in Idaho, as in most other areas, occurring in practically every ore deposit of whatever sort and also in many regions in disseminated form in the country rock. In ores it is usually a valueless and troublesome associate of valuable metallic minerals, although in gold veins the pyrite is sometimes notably auriferous, and is concentrated and smelted for its gold content. When available in large bodies adjacent to markets, pyrite is burned for the production of sulphuric acid, but deposits of the mineral sufficiently large and pure for this purpose have not as yet been found in Idaho in situations favorable for economic exploitation. Only the more important of the known occurrences in the State are mentioned below.



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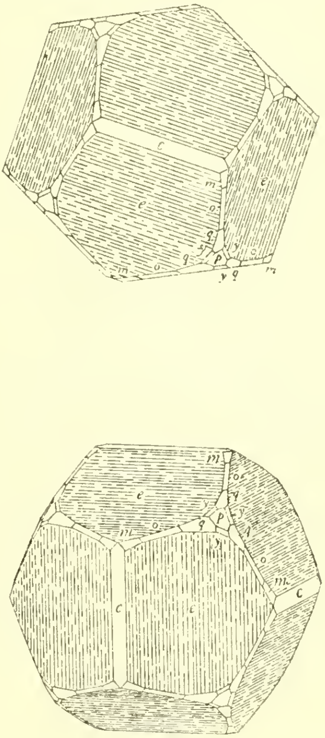


8

Figs. 7-8.—7, Small pyrite crystals embedded in quartz, Croesus mine, Blaine County. 8, Pyrite. Dominantly pyritohedral crystals embedded in calcite from the Parker mine, Warm Springs district, Blaine County

BLAINE COUNTY

Pyrite occurring in the gold veins of this county is auriferous, as in the Camas, Tip Top, Croesus, Wide West, and other mines. A specimen from the Croesus mine in the Hailey gold belt shows rather highly modified pyrite crystals in quartz. One crystal from this specimen was measured and had the forms and habit shown in Figure 7. The forms and angles measured are given in the following table:

Measurements of pyrite from Croesus mine

Form		Symbol		Quality, description	Measured		Calculated	
No.	Letter	Miller	Gdt.		φ	ρ	φ	ρ
					° ′	° ′	° ′	° ′
1	*c*	001	0	Excellent, striated	--------	0 00	--------	0 00
2		010	0∞	do	0 00	90 00	0 00	90 00
3	*e*	012	0½	do	0 00	26 35	0 00	26 34
4		021	02	do	0 00	63 20	0 00	63 26
5		120	½0	Excellent	26 24	90 00	26 34	90 00
6	*p*	111	1	Very good	45 01	54 36	45 00	54 44
7	*r*	123	$\frac{1}{3}\frac{2}{3}$	do	26 17	36 20	26 34	36 42
8		132	$\frac{1}{2}\frac{3}{2}$	do	18 16	58 02	18 26	57 41
9		231	23	Excellent	33 31	74 31	33 41	74 30
10	*H*	249	$\frac{2}{9}\frac{4}{9}$	Very good	26 31	26 36	26 34	26 25

The crystals, though small, rarely reaching 5 mm. in diameter, are lustrous and yield excellent reflections. They are easily separated from the inclosing quartz gangue. The specimen from which the measured crystal was taken is labeled as from the stope on the long 5 drift on the fourth level, Croesus mine.

A specimen of ore from the Parker mine, Warm Springs district, shows brilliant and modified pyrite crystals in coarse white calcite associated with quartz containing sphalerite. One of these which was measured had the forms and habit shown in Figure 8 and gave the following measurements:

Measurements of pyrite from Parker mine

Form		Symbol		Quality, description	Measured		Calculated	
No.	Letter	Miller	Gdt.		φ	ρ	φ	ρ
					° ′	° ′	° ′	° ′
1	*c*	001	0	Good	--------	0 00	--------	0 00
2		010	0∞	Very good	0 00	90 00	0 00	90 00
3	*e*	012	0½	Poor, double	1 11	26 20	0 00	26 34
4	*p*	111	1	Excellent	45 20	55 00	45 00	54 44
5	*q*	121	12	Very good	26 54	66 02	26 34	65 54
6	*o*	252	$1\frac{5}{2}$	Medium	21 17	70 09	21 48	69 37
7	*m*	131	13	Fair	18 43	72 48	18 26	72 27
8	*y*	234	$\frac{1}{2}\frac{3}{4}$	Very poor, blurred	32 33	40 00	33 41	42 02

Specimens from the fifth level of the Muldoon mine, Little Wood River (Muldoon) district, contain numerous well-formed pyrite crystals of pyritohedral habit embedded in sericite.

BOISE COONTY

In the various mining districts of Boise County pyrite is abundant, not only in the gold-bearing veins but also in the altered wall rock adjacent to the veins where it accompanies sericite. In the Quartzburg district, in the Mountain Chief mine, pyrite occurs in the richest ores as large pale masses consisting of imperfect cubic crystals up to 3 cm. in diameter with bismuthinite in quartz sometimes intergrown with sphalerite, arsenopyrite, and chalcopyrite in masses of auriferous sulphides, or as small brilliant cubic crystals disseminated in the sericitized wall rock adjacent to the veins. In ore from the Native Missourian mine auriferous pyrite occurs with sphalerite as small disseminated grains in quartz. At the Carroll-Driscoll property pyrite is intergrown with other auriferous sulphides in quartz in the ore and also as large masses embedded in sericite gouge, the latter often showing pyritohedral crystals up to 1.5 cm. in diameter. This is the best crystallized pyrite thus far examined from the State. Some of the crystals are rather highly modified. A portion of one of the more complex individuals was measured and is faithfully reproduced in the drawing (fig. 9). This gave the angles recorded in the table below. Several of the forms appear to be new but require substantiation, so that no letters have been assigned them, the faces in the drawing being merely numbered to agree with the table. The crystallized pyrite from this locality requires further crystallographic study.

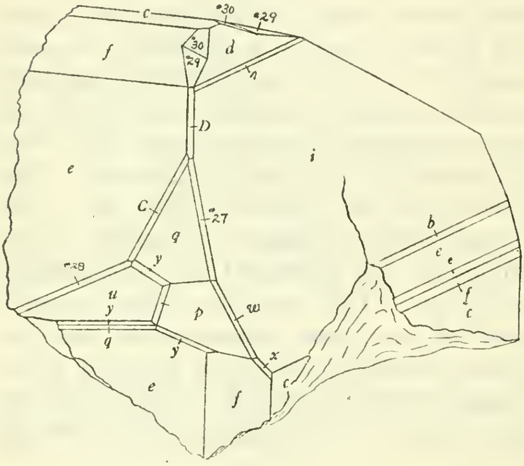
Measurements of pyrite from Carroll-Driscoll mine

Form		Symbol		Quality, description	Measured				Calculated			
No.	Letter	Miller	Gdt.		φ		ρ		φ		ρ	
					°	′	°	′	°	′	°	′
1	*c*	001	0	Very good			0	00			0	00
2		010	0∞	do	0	00	90	00	0	00	90	00
3	*f*	014	0¼	Excellent	0	00	14	04	0	00	14	02
4		041	04	Good	0	00	76	26	0	00	75	58
5	e	027	0−	Poor, oscillated	0	00	15	24	0	00	15	56
6		072	0−	Poor, blurred	0	00	73	40	0	00	74	03
7	*e*	012	0½	Excellent	0	00	26	39	0	00	26	34
8		021	02	Blurred	0	00	62	46	0	00	63	26
9		120	∞2	Good	26	66	90	00	26	34	90	00
10	*b*	032	0−	Medium	0	00	56	25	0	00	56	18
11	*i*	043	0−	Excellent	0	00	53	00	0	00	53	08
12		034	0¾	do	0	00	37	00	0	00	36	52
13		340	∞−	Very good	36	51	90	00	36	52	90	00
14		0. 11. 9	0−	Medium	0	00	50	16	0	00	50	42
15		670	∞−	Very poor, striated	40	13	90	00	40	36	90	00
16	*d*	011	01	Good	0	00	44	55	0	00	45	00
17	*q*	112	½	Excellent	44	43	35	08	45	00	35	16
18		121	12	Medium, striated	26	06	65	51	26	34	65	54
19	*p*	111	1	Excellent	44	40	54	37	45	00	54	44
20	*u*	122	½1	do	26	06	48	04	26	34	48	11
21	*w*	233	−1	Very poor, dim	31	31	52	13	33	41	50	14
22	*C′*	148	−½	Very poor, no sig	15	50	27	10	14	02	27	16
23	*D*	236	−½	Medium	32	11	30	45	33	41	31	00
24	*y*	234	½¾	Poor	32	26	42	41	33	41	42	02
25		243		Poor, striated	26	06	58	58	26	34	56	08
26	*x*	231	23	Very poor	31	56	71	33	33	41	74	30
27	(1)	6. 10. 15		Medium	32	07	37	26	30	58	37	52
28	(1)	2. 7. 10		Very poor	15	50	36	30	15	57	36	03
29	(1)	128	−¼	do	27	37	15	34	26	34	15	37
30	(1)	4. 5. 20	−¼	Medium	40	08	18	19	38	40	17	45

---

[1] Indicates probable but unsubstantiated new form.

A specimen from the dump of the Gold Hill mine consists of quartz porphyry containing abundantly disseminated pyritohedral crystals of pyrite. A large and completely sericitized phenocryst of feldspar in this rock carries groups of slightly larger pyrite crystals of dominantly cubic habit with the modifying faces shown in Figure 10. The forms and angles measured on one of these crystals are given in the following table:



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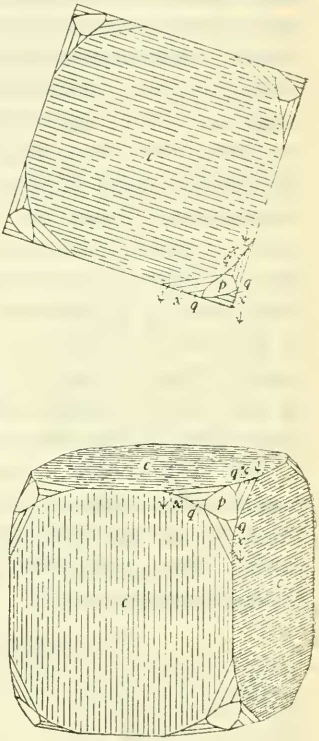

10

Figs. 9-10.—9, Pyrite. Highly modified crystal from Carroll-Driscoll mine, Boise County. 10, Pyrite. Dominantly cubic crystal from sericitized feldspar. Gold Hill mine, Boise County

Measurements of pyrite from Gold Hill mine

Form		Symbol		Quality, description	Measured				Calculated			
No.	Letter	Miller	Gdt.		φ		ρ		φ		ρ	
					°	′	°	′	°	′	°	′
1	c	001	0	Good, striated	------		0	00	------		0	00
2		010	0∞	do	0	00	90	00	0	00	90	00
3	p	111	1	Very good	45	02	54	47	45	00	54	44
4	u	122	$\frac{1}{2}\frac{1}{2}$	Fair, small	26	32	48	10	26	34	48	11
5	x	123	$\frac{1}{3}\frac{2}{3}$	do	26	32	36	43	26	34	36	42
6		132	$\frac{1}{2}\frac{3}{2}$	Fair	18	26	57	44	18	26	57	41
7	φ	124	$\frac{1}{4}\frac{1}{2}$	Fair, small	26	32	30	00	26	34	29	12

Nodules of pyrite inclosed in clay of Neocene lake beds on Turners claim near Idaho City contain some gold and silver.[10] In ore from the gold vein of the Golden Age mine, Pioneerville district, auriferous pyrite occurs in cubic crystals with sphalerite, and in a specimen of typical ore from a stope below the tunnel level of this mine it is abundant in grains and imperfect bright crystals with galena sphalerite and tetrahedrite, disseminated through somewhat crushed quartz associated with sericitized granite. In a specimen from the Coon Dog No. 1 vein striated cubic crystals of pyrite up to 1 cm. on an edge are embedded in quartz with chalcopyrite and sphalerite, the latter being coated on fractures with covellite. In the Coon Dog No. 4 pyrite occurs in coarse cubic crystals thickly disseminated in quartz in a 65 cm. (26-inch) vein of sulphides in granite porphyry, where it is associated with abundant chalcopyrite and a little of a reddish gray antimonial mineral which may be tetrahedrite but which resembles famatinite. This ore contains good values in silver. Masses of coarse imperfect striated pyritohedral crystals occur in ore from the Gem of the Mountains mine, and in the Overlook mine coarse imperfect pyrite crystals are intergrown with galena, sphalerite, and tetrahedrite forming masses of sulphides in quartzose gold ore. In the Blackbird tunnel on the Enterprise vein small brilliant pyrite crystals occur disseminated through sericitized rock and intergrown with sphalerite in the ore, and small brilliant pyritohedral crystals are present in granite on the Fairmont claim.

In the Pearl district much of the gold ore occurs as narrow seams of sulphides in sericitized granite consisting principally of sphalerite and pyrite. Specimens from the Lincoln mine contain small pyrite crystals showing oscillatory combination of cube and pyritohedron in drusy cavities in dark brown sphalerite. Specimens from the Black Pearl dump consist of masses of pyrite with sphalerite and galena in sericitized granite.

CLEARWATER COUNTY

Pyrite is common in gold ores. Specimens from the Lolo M. & P. Co. property, Musselshell (Weippe) district contain pyrite cubes in quartz up to 2 cm. in diameter in part altered to pseudomorphs of limonite.

CUSTER COUNTY

Next to chalcopyrite, pyrite is the most abundant primary sulphide in the lime-silicate contact deposits in limestone in the Alder Creek district. It occurs both as coherent grains and as intricately fractured grains with chalcopyrite along the fractures. The chalcopyrite in many such specimens represents more than half the total area. In some places the pyrite is interstitial with respect to garnet crystals.[11] Pyrite is a persistent mineral in all the deposits in the northwestern part of the county. In the walls of the late Tertiary veins abundant cubes of it accompany the metasomatic alteration.[11a] In a prospect at the head of Little Fall Creek near the head of Lost River well-developed pyrite crystals are associated with galena. At the Red Bird mine in the Bay Horse district on the No. 8 level a mass of pyrite 17 meters (55 feet) wide has been opened. This pyrite occurs as fine-grained masses and also as porous aggregates of plumose groups of crystals which resemble marcasite but are of pyritohedral form.

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[10] Waldemar Lindgren. U. S. Geol. Survey, 18th Ann. Rept., pt. 3, p. 665, 1898.

ELMORE COUNTY

Pyrite is common in all mines. Small pyritohedrons are disseminated in silicified and mineralized granite from the Boise-Rochester mine, Atlanta district.

IDAHO COUNTY

Pyrite is a constituent of the gold ores of most Idaho County districts and is usually auriferous. It occurs scattered through the quartz of the ores in only moderate amount. Large imperfect crystals, grains, and masses accompany minute amounts of galena and chalcopyrite in ore from the Hercules and Blue Ribbon mines, Elk City district. It is the principal sulphide in the Black Pine mine, also in this district, where it is disseminated in quartz with galena, tetrahedrite, sphalerite, and native gold. The ore of the Mineral Zone mine consists of granular auriferous pyrite in rusty quartz.

In the Buffalo Hump district sparsely distributed auriferous pyrite in quartz forms the gold ore of the Concord (Mother Lode) and other mines.

In the Penman and other mines of the Oro Grande district pyrite, which is practically the only sulphide disseminated in quartz, is again the ore of gold.

In the Thunder Mountain district in the Dewey mine pyrite nodules occurring in volcanic tuff had coarse leaf gold at their center.[12]

LEMHI COUNTY

In Lemhi County pyrite appears in all the deposits, and in the gold veins it is auriferous. In the Mackinaw district it is the most abundant mineral, occurring as coarse cubes included in the quartz, and makes up about one-third of the bulk of the gold ore. A typical specimen of ore from the A. D. & M. mine, Gibbonsville, containing $150 a ton in gold, shows pyrite as the only sulphide as small brilliant cubes in a gangue of quartz and calcite.

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[11] J. B. Umpleby. U. S. Geol. Survey, Prof. Paper 97, p. 54, 1917.

[11a] J. B. Umpleby. U. S. Geol. Survey, Bull. 539, p. 53, 1913.

[12] J. B. Umpleby and D. C. Livingston. Idaho State Bur. Mines and Geol., Bull. 3, p. 6, 1920.

In a specimen from the Rabbitfoot mine in the eastern part of the Gravel Range district pyrite appears in an unusual form. Lithophysae-like cavities in silicified rhyolite contain tabular hexagonal crystals up to 2 mm. in diameter, now composed of granular pyrite. These look very much like pseudomorphs after mica crystals, although it is possible that the original crystals were some other mineral, such as polybasite or pyrrhotite.

OWYHEE COUNTY

In the Silver City and other silver mining districts of Owyhee County pyrite is not common in the veins, but occurs abundantly in the altered lavas of the wall rocks. In the South Mountain district it is a constituent of heavy masses of intergrown sulphides and contact silicates.

SHOSHONE COUNTY

In Shoshone County pyrite is common in all veins and also over wide areas sparsely disseminated in the sedimentary rocks, especially those of the Prichard formation. In places the pyrite in the slates is in the form of isolated cubic crystals which may reach 5 cm. (2 inches) in diameter. Minute and deeply striated brilliantly lustrous cubic crystals occur with larger crystals of arsenopyrite replacing sericitic slates in the walls of the Stanley antimony vein at Burke. It is universally present in the lead-silver veins but seldom in large pure masses and not often in well-formed crystals. Certain beds of quartzite in the Wardner mines are largely replaced by pyrite so fine grained as to be difficult of recognition. This pyrite decomposes very readily and specimens, when placed in a dry place become coated with a hairlike growth of crystals of ferrous sulphate. The temperature of certain stopes in the Bunker Hill mine is greatly raised by the heat generated by the decomposing pyrite. Fine-grained pyrite occurs abundantly, intergrown with pyrrhotite and some chalcopyrite, in a quartz-ankerite gangue in nonproductive veins of the "Wisconsin type" east of Kellogg. Beautifully iridescent druses of minute crystals appear in vuggy quartz in the Lombardy vein in Italian Gulch north of Kellogg and druses of brilliant crystals occur in a gouge in a small tunnel overlooking Elk Creek Slough above the mouth of Elk Creek. Pyritohedral crystals 2 cm. (1 inch) or less in diameter have been found in sericitic shale in the Yankee Boy silver mine on Big Creek. Globular and sperical forms of pyrite with internally radiating structure have been obtained from the Greenhill-Cleveland mine at Mace and the Gold Hunter mine at Mullan. Pyrite occurs in intimate intergrowth with galena and sphalerite in many of the mines of the Pine Creek Basin. The pyrite in the Golden Chest and other gold mines of the Murray section is auriferous.

WASHINGTON COUNTY

In Washington County many of the large hematite deposits in the vicinity of Iron Mountain have been found to pass at shallow depth into massive bodies of pyrite. On the Segwine claims a 5-meter (15-foot) lens of pyrite is exposed and in the Little Gem claim there is a vein of pyrite 2 meters (7 feet) wide and a zone of garnet rock thickly impregnated with pyrite for a width of 30 meters (90 feet).[13]

In the Mineral district pyrite occurs commonly in gold and silver ores associated with galena, sphalerite, tetrahedrite, etc. An unusual variety has been reported from this district containing 10.9 per cent of manganese [14] and a little silver.

COBALTITE (89)

Cobalt sulpharsenide, $CoS_2.CoAs_2$. Isometric, pyritohedral.

LEMHI COUNTY

Cobaltite is abundant in many cobalt mines and prospects in the Blackbird district being, so far as the specimens at hand indicate, the only important cobalt ore mineral of this field. It occurs as reddish gray grains, crystals, and granular masses.

Very fine-grained reddish patches in schist from the Gray Eagle property are unaltered in the closed tube over the Bunsen burner but at blast temperature give characteristic rings of arsenic sulphide and arsenic, and are thus cobaltite. Ore from the Tom Jefferson claim contains minute reddish-gray crystals of cobaltite with chalcopyrite making up a sulphide band 1 cm. wide in schist. Crystals from this specimen were measured and found to be isometric pyritohedral in crystallization with faces of the cube, octahedron, and pyritohedron. Specimens from the Brooklyn claim also show crystals of cobaltite up to 2 mm. in diameter associated with chalcopyrite. These show rather perfect cubic cleavage. It dissolves with avidity in concentrated nitric acid with separation of sulphur and yields a pink solution which becomes green when a little hydrochloric acid is added. It is unaltered when heated in a closed tube over a Bunsen burner and gives arsenical fumes when heated before the blowpipe on charcoal. It contains no iron and gives no nickel reaction with dimethylglyoxime. The crystals have the forms shown in Figure 13, the cube modified by octahedron and pyritohedron. The measurements which establish their isometric form are given in the following table:

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[13] Robert N. Bell. 20th Ann. Rept. Mining Industry of Idaho, pp. 107–109, Boise, 1918.

[14] Lang. Private communication in supplement sixth edition of Dana's System of Mineralogy, p. 1045.

Measurements of cobaltite from Brooklyn claim

Form		Symbol		Quality, description	Measured		Calculated	
No.	Letter	Miller	Gdt.		φ	ρ	φ	ρ
					° ′	° ′	° ′	° ′
1	c	001	0	Very good		0 00		0 00
2		010	0∞	Good	0 02	90 00	0 00	90 00
3	e	120	∞2	Medium	26 22	90 00	26 34	90 00
4		012	0½	Good	0 00	26 07	0 00	26 34
5		021	02	Medium	0 00	64 20	0 00	63 26
7	p	111	1	Fair	44 56	54 51	45 00	54 44

A specimen collected by Frank L. Hess from the Ludwig and Bascom Latest Out claim on the west fork of Blackbird Creek has abundant small crystals of cobaltite, seldom reaching 1 mm. in diameter, disseminated in streaks in granular quartz containing some schist inclusions (pl. 2, upper). These crystals are easily isolated from the matrix and are found to be cuboctahedrons as shown in Figures 11 and 12. The measurements which identify the forms are, in detail, as follows:

Measurements of cobaltite from Latest Out claim

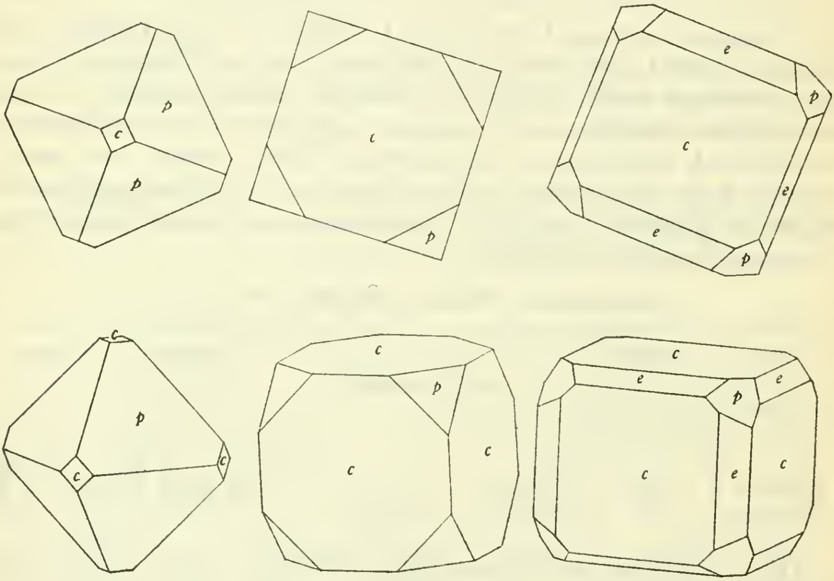
Form		Symbol		Quality, description	Measured		Calculated	
No.	Letter	Miller	Gdt.		φ	ρ	φ	ρ
					° ′	° ′	° ′	° ′
1	c	001	0	Fair		0 00		0 00
2		000	0∞	do	90 00	90 00	90 00	90 00
3	o	111	1	Medium	45 00	54 55	45 00	54 44

This mineral has well-defined cubic cleavage. It behaves like the preceding when heated in the closed tube or on charcoal. A sample separated by heavy solutions from this sample was partially analyzed. It contains 20.08 per cent of sulphur and 2.18 per cent of iron. No trace of nickel could be detected. A specimen from the Wiley J. Rose property 1 mile north of the old camp of Blackbird contains a solid vein of granular cobaltite partly altered to erythrite in a quartzose schist and another specimen from the same vicinity has granular crystalline streaks of cobaltite in schistose quartz making up half the bulk of the specimen. This cobaltite was analyzed, yielding the following results:

Analysis of cobaltite, Lemhi County

Constituent	Per cent.
Cobalt (Co)	32. 38
Iron (Fe)	4. 33
Nickel (Ni)	None.
Arsenic (As)	44. 07
Sulphur (S)	18. 10
Total	98. 88

In the Haynes Stellite Co.'s mine on Blackbird Creek, 4 miles below the old camp of Blackbird and 2 miles above the mouth of the creek, cobaltite occurs as extremely finely diffused microscopic grains of reddish-gray color in black tourmalized quartz associated with larger crystals of danaite. Such material, which makes up the ore, shows no cobaltite to the naked eye unless polished. Another specimen from this property contains crystals of reddish cobaltite up to 5 mm. in diameter disseminated in quartz with schistose biotite, chlorite, and long prisms of apatite (pl. 6, lower). These crystals are, for the most part, simple cubes or octahedrons, and show well-defined cubic cleavage.



11 12 13

Figs. 11-13.—11, Cobaltite. Latest Out claim, Blackbird district, Lemhi County. Cube truncated by octahedron. 12, Cobaltite. Same locality. 13, Cobaltite. Cube truncated by octahedron and pyritohedron. Tom Jefferson claim, Blackbird district

A specimen of ore from the Nickel Plate mine shows granular residual patches of cobaltite in greenish masses of oxidation products consisting principally of olivenite and scorodite.

GERSDORFFITE (90)

Nickel-cobalt-iron sulpharsenide, (Ni, Fe, Co) AsS. Isometric.

An isometric sulpharsenide of nickel, iron, and cobalt recently received for examination and report at the National Museum may be classed as gersdorffite.

COBALTITE

FOR DESCRIPTION OF PLATE SEE PAGES 133 AND 134

SHOSHONE COUNTY

A lot of material received from Erwin Ploetzke contained a gray sulpharsenide of nickel, cobalt, and iron. The specimens were mailed from Burke and a letter accompanying them stated that they were from a prospect of Mr. Ploetzke in Idaho. Inquiries as to the exact locality met with no reply from Mr. Ploetzke. Recently an identical lot of material was received from A. Beals, of Avery, Idaho. An inquiry directed to Mr. Beals elicited the information that both lots were from the same prospect, in which Ploetzke is a partner, and which is located 7 miles from Avery on Slate Creek, 1 mile from the mouth of the creek.

The specimens consist of greasy-appearing greenish sheared quartz containing the gersdorffite associated with pyrrhotite and chalcopyrite. The gangue shows a small amount of a grayish carbonate, probably ankerite. The quartz contains small open spaces lined with imperfect quartz crystals on which rest occasional whitish crystals of barite and minute pale green globular or barrel-shaped aggregates of a scaly micaceous mineral. The latter is probably a chlorite. It is biaxial positive with 2V medium small, estimated at 30°, and refractive index about 1.62. As a later deposit in the cavities there occur rose-red crusts of minute crystals of erythrite (cobalt bloom) too small to be measured but identified by their characteristic optical properties, and some dead-black material which may be heterogenite.

The gersdorffite occurs in masses up to several centimeters in diameter either alone or mixed with the other sulphides. The mineral is not massive but consists of closely spaced small individual crystals, less than a millimeter in diameter, separated by quartz. Portions may be selected with a large proportion of the mineral and practically free from the other sulphides. Such were crushed and sized by screening and the quartz separated with methylene iodide. A few grains of pyrrhotite were extracted with a hand magnet. Microscopic examination showed this prepared sample to be free from other sulphides. It was analyzed, yielding the following results and ratios:

Analysis and ratios of gersdorffite from Avery

(E. V. Shannon, analyst)

	Per cent	Calculations of ratios		
Quartz	3.48			
Cobalt	9.09	0.154	0.586	1.02×1
Nickel	14.28	.243		
Iron	10.57	.189		
Arsenic	43.80	.584	.584	1.02×1
Sulphur	17.70	.552	.552	.96×1
Total	98.92			

The ratios indicate the formula (Ni, Fe, Co) AsS with the ratios Ni:Fe:Co = 7:5:4, approximately.

The crystals can be isolated from the quartz and those which were measured were found to be isometric combinations of cube and octahedron.

It is evident that the mineral is a member of the pyrite group and a sulpharsenide of nickel, iron, and cobalt. It is thus an intermediate 3-component isomorphous mixture of the gersdorffite and cobaltite molecules with a hypothetical iron sulpharsenide not yet recognized as a distinct mineral. Since the gersdorffite molecule is definitely predominant over the others in it, the present mineral may be designated gersdorffite.

The color of the mineral is steel gray, like arsenopyrite. After exposure it dulls with the assumption of a barely perceptible reddish tinge. In the closed tube it gives, like arsenopyrite, copious sublimates of arsenic sulphide and arsenic.

Polished surfaces of the ore, examined in reflected light, disclose the angular gersdorffite which has probably replaced the quartz metasomatically. Pyrrhotite occurs in a network of fine seams forming the matrix of angular quartz grains. The only other metallic mineral present is white in color and is unattacked by the usual etching reagents, including nitric acid and acid permanganate. This may be pentlandite. It is in very small amount and bears the same relation to the quartz as the pyrrhotite.

The gersdorffite is resistant to all reagents, except that with long etching with acid permanganate a faint zoning becomes visible by the slight darkening of certain zones in the crystals showing, probably, differences in composition.

The associated pyrrhotite, when separated and purified, contains a mere trace of nickel.

ARSENOPYRITE (98)

Iron sulpharsenide, FeAsS. Orthorhombic.

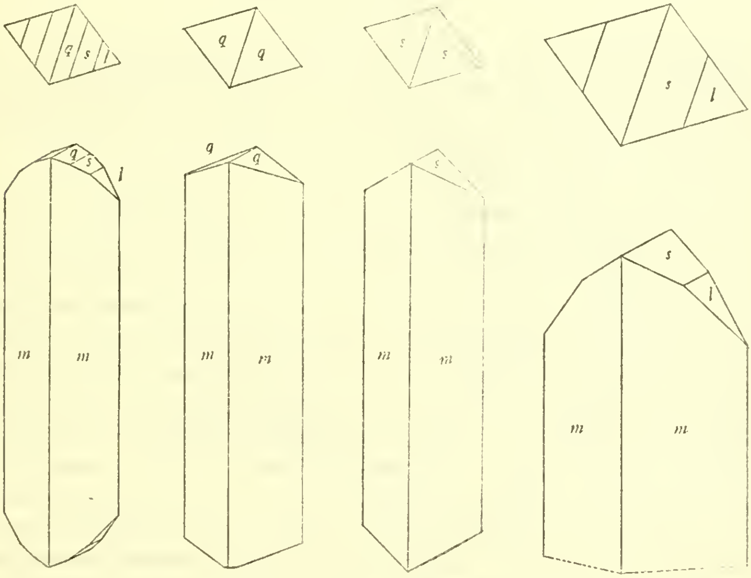
Arsenopyrite, commonly known as arsenical pyrites, or mispickel, occurs rather widely in Idaho as an accessory mineral in lead, zinc, gold, and antimony veins. While usually not itself of commercial value it sometimes contains notable amounts of gold and, occasionally, of silver. The arsenic content complicates the metallurgical treatment of the ores and usually a penalty is assessed against arsenical ores by smelters. Where in large bodies favorably situated this mineral has a prospective value as a source for arsenic which is in demand for the manufacture of poisonous insecticides. No bodies of commercial arsenopyrite have thus far been developed in Idaho. Such occurrences of the mineral as have been brought to the writer's attention are mentioned below.

ADA COUNTY

Arsenopyrite is mentioned as a prominent accessory constituent of gold ores, especially of the Black Hornet district.

BLAINE COUNTY

Arsenopyrite occurs commonly in the gold ores of the Hailey gold belt at the Red Cloud, Croesus, and other mines and also in many of the lead-silver mines of the Wood River region, including the Minnie Moore, Independence, North Star, etc. A specimen from the Red Cloud mine shows prismatic crystals and granular aggregates of arsenopyrite with pyrite and galena. Arsenopyrite is especially prominent in the complex ores of the North Star mine, where it is associated in quartz and carbonate gangue with galena, dark brown sphalerite and boulangerite. Much of the arsenopyrite from this mine has a pale yellow color like that of pyrite, which is rather persistent, but which disappears when the mineral is inmersed in hydrochloric acid. The mineral sometimes occurs in a rather spectacular form as slender prisms embedded in sphalerite. Crystals for examination were obtained by dissolving out ankerite occurring as gangue. These are prismatic by elongation of the vertical axis, the most prominent form being the unit prism $m(110)$. The prisms taper somewhat and where terminated show the forms $l(011)$, $s(012)$, and $q(013)$, either singly or together. The forms and relative proportions of the



14 15 16 17

Figs. 14–17.—14–16, Arsenopyrite. Star mine, Wood River district, Blaine County. 17, Arsenopyrite. Crystal from vug in siderite, Ramshorn mine, Custer County crystals from this locality are shown in the drawings, Figures 14, 15, and 16.

Arsenopyrite is also common in veins near Carrietown in the Rosetta and Warm Spring districts west of the Hailey quadrangle. A specimen from the Dollarhide mine, No. 3 level, shows arsenopyrite as small prisms in quartz with galena and sphalerite. In ore from the Silver Star claim disseminated minute prisms of arsenopyrite are associated with pyrite and galena in quartz and siderite and in the Stormy Galore mine minute steel gray prisms of arsenopyrite occur in wall rock inclusions in siderite.

BOISE COUNTY

Arsenopyrite is of very general occurrence in lode gold ores. In the Pearl district ore from the I. X. L. mine consist of quartz with abundant finely disseminated arsenopyrite. Small vugs contain brilliant arsenopyrite crystals associated with minute crystals of dolomite and quartz. Heavy auriferous sulphide ore from the West Coast mine contains more arsenopyrite than all other sulphides together. In ore from the Checkmate mine minute perfect tin-white arsenopyrite crystals occur abundantly disseminated through altered granite which is seamed with quartz and auriferous sulphides. Other specimens from this mine show fine massive granular arsenopyrite with pyrite and sphalerite forming heavy masses of auriferous sulphides, in vugs of which arsenopyrite appears in small perfect crystals. Specimens of massive auriferous sulphide ore from the Mountain Chief mine, Quartzburg district, show predominant arsenopyrite with pyrite and chalcopyrite and vugs with arsenopyrite crystals. A specimen from the Gem of The Mountains mine of the Diana Mines Co., Pioneerville district, contains arsenopyrite sparingly as crystals in comb quartz with galena and pyrite.

CUSTER COUNTY

Arsenopyrite occurs as an accessory mineral in the tetrahedrite-siderite ores of the Bay Horse district. A specimen from the Ramshorn mine illustrated by Umpleby[15] shows a seam along which prisms of arsenopyrite are developed in siderite. The crystals of this specimen, when freed by solution of the siderite in acid, were found to have the form shown in Figure 16. The angles measured on them are as follows:

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[15] Joseph B. Umpleby. U. S. Geol. Survey, Bull. 539, pl. 7, lower.

Angles of arsenopyrite from Ramshorn mine

Form		Symbol		Description, quality	Observed		Calculated	
No.	Letter	Gdt.	Miller		φ	ρ	φ	ρ
					° ′	° ′	° ′	° ′
1	*m*	∞	110	Good, very good	55 53	90 00	55 46	90 00
2	*s*	0½	012	Good	0 13	30 34	0 00	30 47

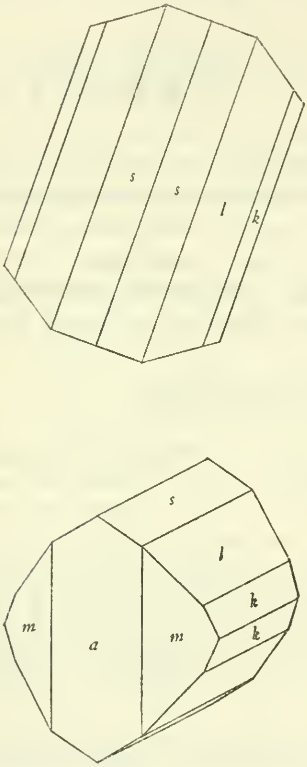
In another specimen (Cu 88) from the No. 5 tunnel, Utah Boy Claim, Ramshorn mine, stout prismatic crystals of arsenopyrite of the form shown in Figure 17 occur in vugs in siderite-tetrahedrite ore associated with crystals of siderite and tetrahedrite crystals which are coated with mossy chalcopyrite. The arsenopyrite crystal from this specimen which was measured gave the following forms and angles:

Forms and angles of Arsenopyrite, Ramshorn mine

N form		Symbol		Description, quality	Observed		Calculated	
No.	Letter	Gdt.	Miller		φ	ρ	φ	ρ
					° ′	° ′	° ′	° ′
1	*m*	∞	110	Poor, striated	57 04	90 00	55 46	90 00
2	*m*	∞	110	do	55 48	90 00	55 46	90 00
3	*m*	∞	110	do	56 46	90 00	55 46	90 00
4	*m*	∞	110	do	55 23	90 00	55 46	90 00
5	*l*	01	011	Excellent	0 00	49 12	0 00	49 59
6	*l*	01	011	Fair	1 24	49 12	0 00	49 59
7	*s*	0½	012	Very poor, dull	0 58	32 32	0 00	30 47
8	*s*	0½	012	Poor, dull	1 34	32 32	0 00	30 47

Very minute arsenopyrite crystals also occur included in wall rock fragments inclosed in the vein.

In the Washington Basin district arsenopyrite is common in great veins and masses of iron sulphides in the Empire claims of the Idaho Montgomery Mining Co. Specimens show the mineral thickly impregnating greenstone and forming heavy lumps. This arsenopyrite is massive with no evidence of crystal faces or cleavage and has conchoidal fracture. Where freshly broken it is silver white but it tarnishes iridescent purplish like bornite. When heated in the closed tube the mineral gave the arsenic sulphide and arsenic rings characteristic of arsenopyrite and reacted abundantly for iron by wet methods. Careful tests for cobalt, nickel, antimony, and copper gave negative results. A specimen from 200 meters (600 feet) south of the north end of the Empire ledge shows gray crystals up to 1 cm. in length and averaging 2 mm. disseminated in quartz. These are gray on fresh fracture, have conchoidal fracture and tarnish purplish. Such material was reported to contain 17 per cent of nickel but the selected arsenopyrite, which is the only metallic mineral, gave no trace of nickel when tested with dimethylglyoxime. The closed tube reactions are those of arsenopyrite. One crystal was freed from the inclosing quartz and measured. This gave the angles of arsenopyrite and was found to be prismatic by elongation on the *a* axis. This crystal is illustrated in Figure 18. The forms and angles measured are as follows:



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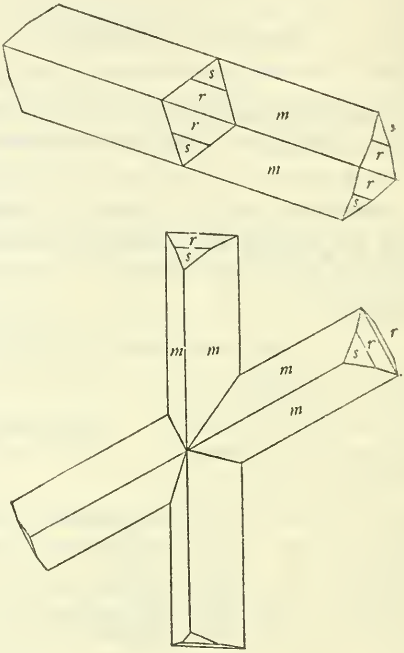


19

FIGS. 18–19.—18, ARSENOPYRITE. GRAY CRYSTAL EMBEDDED IN QUARTZ. WASHINGTON BASIN DISTRICT, CUSTER COUNTY. 19, ARSENOPYRITE. TWINNED CRYSTAL. PROJECTED ON (010). HYPOTHEEK MINE, SHOSHONE COUNTY

Measurements of arsenopyrite from Washington Basin

Form		Symbol		Quality, description	Measured		Calculated	
No.	Letter	Miller	Gdt.		φ	ρ	φ	ρ
					° ′	° ′	° ′	° ′
1	a	100	∞0	Very poor, striated	90 00	90 00	90 00	90 00
2	m	110	∞	Medium	56 02	90 00	55 46	90 00
3		110	∞	Very poor, no signal	56 02	90 00	56 02	90 00
4	s	012	0½	Good	0 00	31 30	0 00	30 47
5	s	012	0½	do	0 00	30 19	0 00	30 47
6	l	011	01	do	0 00	50 18	0 00	49 59
7	l	011	01	do	0 00	50 35	0 00	49 59
8	l	011	01	do	0 00	49 26	0 00	49 59
9	k	021	02	Medium	0 00	67 00	0 00	67 14
10	k	021	02	Poor	0 00	67 49	0 00	67 14
11	k	021	02	Fair	0 00	67 00	0 00	67 14

ELMORE COUNTY

Arsenopyrite occurs with gold in the Neal and Rocky Bar districts. Specimens from the Vishnu mine, Rocky Bar district show it as reddish-tarnishing gray masses and imperfect crystals in quartz.

IDAHO COUNTY

Arsenopyrite is reported from the Goodenough and other gold veins in the Warren district. A specimen of ore from the South Fork mine, 7 miles southwest of Elk City, Elk City district, shows small sharp steel-gray crystals of this mineral in quartz.

LEMHI COUNTY

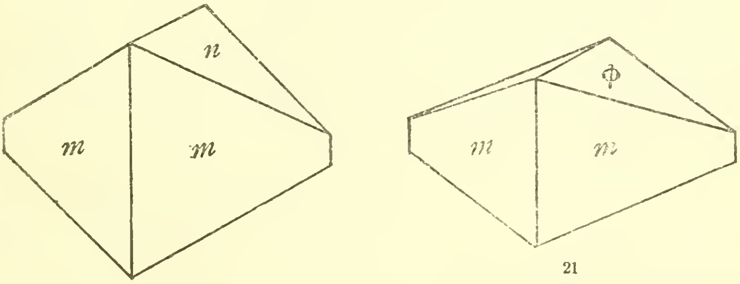
Arsenopyrite occurs in gold ores of the Mineral Hill district. The cobaltiferous variety, danaite, which is common in the cobalt ores of the Blackbird district is described below (page 143).

OWYHEE COUNTY

In Owyhee County arsenopyrite is associated with sphalerite, galena, etc., in the lead ores of the South Mountain district. A specimen from the Bay State mine dump, this district, has abundant arsenopyrite with some black sphalerite and a little galena and chalcopyrite. The arsenopyrite is well crystallized in crystals of simple habit up to 1 cm. long.

SHOSHONE COUNTY

Arsenopyrite is a rather uncommon mineral in the Coeur d'Alene district and is practically absent from the larger lead-silver mines. Small crystals have been noted in slaty sericitic rock adjacent to small quartz veins containing jamesonite in the stope above the 2,000 foot level of the Standard Mammoth mine at Mace. Iron gray crystals of the forms shown in Figures 20 and 21 occur in slaty rock inclusions in the quartz-stibnite ore of the Stanley antimony mine in Gorge Gulch above Burke. This arsenopyrite has a dull lead gray



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21

FIGS. 20–21.—ARSENOPYRITE. SMALL CRYSTALS EMBEDDED IN SLATE. STANLEY ANTIMONY MINE, BURKE, SHOSHONE COUNTY color on fresh fracture but was proven to be of normal composition and free from antimony by qualitative tests. Similar crystals have been seen rarely in the Evolution mine near Osburn and in ore from the Pearson antimony mine on Pine Creek, also in specimens of ore from the Liberal King and Casey prospects on Pine Creek. Brilliant silver white crystals occur replacing wall rock in the O. K. mine in Government Gulch and the Corby prospect on Pine Creek and also in the ore of the Hypotheek mine near Kingston in a quartz carbonate gangue with pyrite, chalcopyrite, and tetrahedrite. Some of those from the Hypotheek mine were obtained free by dissolving the carbonate gangue in acid. These were prismatic by vertical elongation, being essentially like Figures 14 to 16. The terminal faces are striated and yield poor measurements which indicate the forms to be *s*(012) and *r*(014). The angular values are shown in the following table:

Forms and angles of simple arsenopyrite crystal from the Hypotheek mine

Form		Symbol		Quality, description	Measured		Calculated	
No.	Letter	Gdt.	Miller		φ	ρ	φ	ρ
					° ′	° ′	° ′	° ′
1	*m*	∞	110	Fair	55 07	90 00	55 46	90 00
2	*m*	∞	110	do	55 53	90 00	55 46	90 00
3	*m*	∞	110	do	55 34	90 00	55 46	90 00
4	*m*	∞	110	do	56 05	90 00	55 46	90 00
5	*s*	0½	012	Poor	0 53	28 10	0 00	30 47
6	*s*	0½	012	Very poor	0 00	27 15	0 00	30 47
7	*r*	0¼	014	do	0 53	14 34	0 00	16 35
8	*r*	0¼	014	do	0 00	16 19	0 00	16 35

The crystals from the Hypotheek mine are frequently twinned on the front dome (101), the commonest twinning law for arsenopyrite. Such a twinned crystal which was measured is shown, projected on the *b* pinacoid, in Figure 19. The measurements obtained on this crystal are given in the following table:

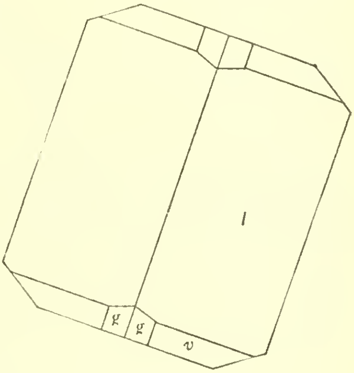
Forms and angles of twinned arsenopyrite crystal from the Hypotheek mine

Form		Symbol		Quality, description	Measured		Calculated	
No.	Letter	Gdt.	Miller		φ	ρ	φ	ρ
					° ′	° ′	° ′	° ′
1	*m*	∞	110	Excellent	55 45	90 00	55 46	90 00
2	*m*	∞	110	Medium	55 43	90 00	55 46	90 00
3	*m*	∞	110	Very poor	54 46	90 09	55 46	90 00
4	*m*	∞	110	Fair	55 46	90 00	55 46	90 00
5	$\bar{m}$	∞	110	Medium	36 43	44 07		
6	*m*	∞	110	do	33 56	44 44		
7	*s*	0½	012	Fair	0 02	29 24	0 00	30 47
8	*s*	0½	012	do	0 02	29 24	0 00	30 47
9	$\bar{s}$	0½	012	Good	58 00	63 34		
10	$\bar{s}$	0½	012	Medium	56 28	63 18		
11	$\bar{r}$	0¼	014	Fair	71 00	60 25		

The tetrahedrite associated with the arsenopyrite from the Hypotheek mine is free from silver and arsenic. The arsenopyrite gives the usual closed tube reactions and gave negative results when tested for antimony.

It is interesting to note that in many of its occurrences in the State the arsenopyrite is intimately associated with antimonial minerals, either boulangerite, jamesonite, stibnite, or tetrahedrite, yet in no case is the arsenopyrite antimonial nor do the associated antimony minerals contain any arsenic.

The variability in color of this mineral deserves mention. Although commonly tin white, varieties were noted from several localities where the color, even on fresh fracture, is dull gray or reddish-gray. Such occurrences were carefully tested and all found to be of normal composition.



DANAITE

Cobaltiferous arsenopyrite.

LEMHI COUNTY

Arsenopyrite is probably a more or less common constituent of the cobalt ores of the Blackbird district where it is cobalt bearing and associated with cobaltite. It was found by chemical tests to be a microscopic constituent of a chlorite-chloritoid rock from the Nickel Plate mine. Polished specimens of typical ore from the Haynes Stellite Co.'s mine on Blackbird Creek 2 miles above the mouth of the creek, collected by Frank L. Hess show silver-white crystals up to 5 mm. in diameter sparingly disseminated in a quartz tourmaline rock containing finely disseminated cobaltite. The large crystals are of the cobaltiferous variety of arsenopyrite which has been given the varietal name danaite. By carefully cracking away the surrounding gangue it was found possible to secure one of these crystals which was suitable for goniometric measurement. These crystals are stout prismatic by elongation of the *a* axis and have the habit shown in the drawing figure 22, the dominant forms

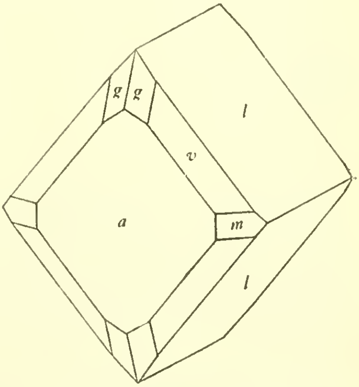


Fig. 22.—Danaite. White crystals embedded in ore. Haynes-Stellite mine, Blackbird district, Lemhi County

being the pinacoid *a*(100) and the dome *l*(011) with smaller faces of *m*(110), *g*(111), and *v*(212). The measurements obtained are as follows:

Forms and angles on danaite from Lemhi County

Form		Symbol		Quality, description	Measured		Calculated	
No.	Letter	Gdt.	Miller		φ	ρ	φ	ρ
					° ′	° ′	° ′	° ′
1	*m*	∞	110	Medium poor	56 32	90 00	55 46	90 00
2	*m*	∞	110	do	56 30	90 00	55 46	90 00
3	*l*	01	011	Poor	0 06	49 22	0 00	49 59
4	*l*	01	011	do	0 04	49 22	0 00	49 59
5	*g*	1	111	Good	56 23	65 26	55 46	64 44
6	*v*	1½	212	Medium	70 55	61 58	71 13	61 36

A crystal of the danaite which on polished surface appeared pure and homogeneous was analyzed, yielding good results although, after deducting adhering gangue, the sample weighed only 0.1482 gram. The results of this analysis are given in column 1 below while in columns 2 and 3 are given, for comparison, analyses of danaite from the original locality, Franconia, N. H., and from Skutterud, Norway.[16]

Analyses of danaite

	(1) Idaho	(2) New Hampshire	(3) Norway
Arsenic	46.93	41.44	46.76
Sulphur	17.10	17.84	17.34
Iron	27.26	32.94	26.36
Cobalt	8.71	6.45	9.01
Total	100.00	98.67	99.47

As shown by the analysis the Idaho material is even higher in cobalt than the original material to which the varietal name was given. The mineral contained no trace of nickel as tested with dimethylglyoxime. The blowpipe reactions are the usual ones for arsenopyrite. In the closed tube in the bunsen flame a broad reddish-black ring of arsenic sulphide above a brilliant metallic ring of metallic arsenic is obtained. This test serves to distinguish arsenopyrite from the associated cobaltite, which requires heating over the blast flame to a much higher temperature before these characteristic closed tube rings are formed. In the open tube the danaite gives a copious sublimate of arsenic trioxide and fumes of sulphur dioxide. It is soluble in hot concentrated nitric acid with separation of some sulphur. The solution, after being diluted with water, is faintly pink.

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[16] Dana, System of mineralogy, sixth edition, p. 99.

MARCASITE (96)

Iron disulphide, FeS_2 Orthorhombic

Marcasite, commonly called white iron pyrite, is identical with pyrite in composition but differs in crystallization. When it is massive it is difficult to distinguish from pyrite, although it is usually paler in color and is more readily decomposed by weathering. It is much rarer than pyrite.

BLAINE COUNTY

Marcasite is reported to have been mined in the Wood River district as an ore of gold.[17]

OWYHEE COUNTY

Marcasite occurs in a number of silver mines in the Silver City district. In the Chautauqua tunnel and in the Trade Dollar and De Lamar mines it occurs in dendritic forms in quartz, and in specimens from the Garfield tunnel it is abundant in clay.[18]

LEMHI COUNTY

Beautifully spherical nodules of marcasite up to 1½ inches (4 cm.) in diameter occur in the Tertiary beds a mile south of Salmon These are usually dull on the outside and are aggregated into fantastic forms like those of ordinary concretions. When broken open they are found to consist of very pale greenish granular marcasite having an indistinctly radiated structure. The inclosing rock is loosely cemented clay sandstone.[19]

SHOSHONE COUNTY

In the Gold Hunter mine at Mullan cavities in the ore sometimes contain bright spherical or botryoidal masses of iron sulphide, already mentioned under pyrite. These masses are bright and have a pale yellowish color and brassy luster. The exteriors are usually smooth and when broken open the masses are seen to be radiated columnar in structure. It is quite probable that some of these masses are marcasite.

SYLVANITE (104)

Gold silver telluride (Au, Ag) Te_2. Monoclinic.

Despite the large number of gold veins in Idaho, tellurides have been met but rarely and in small amount. Sylvanite is the name most used by miners and prospectors for ores in which the gold is not visible to the naked eye and reports of the occurrence of sylvanite or of tellurides must be discounted for this reason. So far as known no accurate mineralogical identification of any gold telluride from

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[17] U. S. Geol. Survey, Bull. 624, p. 119, 1917.

[18] Waldemar Lindgren. U. S. Geol. Survey, 20th. Ann. Report, pt. 3, 1900.

[19] J. B. Umpleby. U. S. Geol. Survey, Bull. 528, p. 78, 1913.

Idaho has ever been made and the only locality from which the writer has seen specimens is John Doctors Pilot mine in the Coeur d'Alene district in Shoshone County. The most authentically reported occurrences are as follows:

IDAHO COUNTY

Tellurides of gold and silver occurred in the Little Giant vein in the Warren district associated with argentite and native silver. Lindgren[20] mentions the report, but says that he was unable to find any tellurides when he visited the property.

Tellurides are said to have occurred with galena, pyrite, chalcopyrite, and coarse wire gold in quartz veins on Bear Creek in the Marshall Lake district 40 miles southwest of Buffalo Hump.[21]

Tellurides of gold are reported to occur in the Black Pine mine in the Elk City district as very finely disseminated grains in dark stains in quartz ore containing galena and free gold.

LEWIS COUNTY

Tellurides are said to occur in the Deer Creek property on the southern slope of Craig Mountain on the drainage of Deer Creek, a tributary to Salmon River.[22]

SHOSHONE COUNTY

A gold telluride of silver-white color possessing well-defined cleavage, which is probably sylvanite, was observed by the writer in specimens of tellurium-bearing ore in the possession of John Doctor from a pocket of very rich gold ore found in the Pilot claim at Murray in the Coeur d'Alene district.

KERMESITE (107)

Antimony oxysulphide, Sb_2OS_2. Monoclinic.

Kermesite is a red mineral often found in small amounts in antimonial ores where it has been formed by slight oxidation of stibnite. It is probably present in most of the antimony deposits of the State, but has not been carefully looked for.

SHOSHONE COUNTY

Thin coatings of deep red to brownish red powder on cracks in stibnite from the Stanley antimony mine at Burke are probably kermesite and similar material doubtless occurs in the other antimony mines of the district.

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[20] Waldemar Lindgren. U. S. Geological Survey, 20th Ann. Report, pt. 3, p. 245, 1900.

[21] Robert N. Bell. Mining Industry of Idaho for 1913, p. 176.

[22] D. C. Livingston and F. B. Laney. Idaho Bur. Mines and Geol., Bull. 1, p. 101.

CHALCOSTIBITE (117)

Copper sulphantimonite, $Cu_2S.Sb_2S_3$. Orthorhombic.

Chalcostibite is a comparatively rare mineral which has been doubtfully identified from one mine in Idaho. It is possibly present elsewhere as a gray massive mineral lumped under the name "gray copper," which rightly belongs to tetrahedrite, but which probably includes a number of other minerals containing copper, sulphur, and antimony, which can be identified only by a chemical analysis or by crystallographic study.

SHOSHONE COUNTY

A specimen of "gray copper" collected by F. L. Ransome in the Standard-Mammoth mine in the Coeur d'Alene district was tested qualitatively by Dr. Waldemar T. Schaller, who concluded from its closed tube reaction that it was probably chalcostibite rather than the more common tetrahedrite.[23] The mineral is in grains a few millimeters in diameter intergrown with some chalcopyrite and sparsely disseminated through milky white quartz containing occasional patches of chloropal (?) and galena. Such material has been observed frequently by the writer in the lower levels of both the Greenhill-Cleveland and Standard-Mammoth ore shoots in narrow quartz veins which are later than and cut the main mass of the ore. These sometimes contained vugs in which were developed crystals of this gray mineral up to 1 centimeter in diameter, of rhombic aspect, but so shattered that they fell to pieces almost immediately. Chalcopyrite and chloropal (?) were usually associated with this mineral in the quartz.

GALENOBISMUTITE (118)

Lead sulphobismuthite, $PbS.Bi_2S_3$. Orthorhombic.

BOISE COUNTY

The rare mineral galenobismutite, previously definitely known only from the original locality in Nordmark, Sweden, has been described from the Belzazzar mine in the Quartzburg district.[24]

The specimen, which was selected as a typical specimen of the ore, came from the dump of the Belzazzar mine near the Jerusalem Valley road, a little west of Quartzburg. It consists in the main of translucent to transparent crystalline white vein quartz. The sequence of deposition of the minerals is not entirely clear, but there is a band of more or less pure pyrite adjacent to the wall of the vein which appears to be the earliest mineral of the ore. The quartz is slightly sheeted parallel to the walls of the vein and small grains of pyrite are distributed along the partings. Pyrite occurs also in crystalline grains through the quartz and as sharply bounded cubic crystals in greatly sericitized fragments of wall rock which occur in the quartz. The quartz is loose textured and contains small angular cavities between the crystals. The galenobismutite occurs interstitially with relation to the quartz crystals and projects as fibrous bundles of prismatic needles into the cavities. It is clearly the youngest mineral of the vein, which is the common paragenetic position of the majority of lead sulpho-salts.

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[23] F. L. Ransome. U. S. Geol. Survey, Prof. Paper 62, p. 93, 1908.

[24] Earl V. Shannon. On galenobismutite from a gold quartz vein in Boise County, Idaho. Jour. Washington Academy of Science, vol. 11, pp. 298–300, 1921.

The galenobismutite is rather light gray in color and tarnishes to a yellowish color. Its luster is rather more brilliant than that of the antimonial sulphosalts of lead and the mineral greatly resembles bismuthinite in general appearance. It forms elongated prisms imbedded in quartz or minute deeply striated crystals in open cavities. The streak is black on porcelain or brownish black when rubbed. The hardness is about 2.5.

Material for analysis was secured free from other impurities than quartz and pyrite as shown by microscopic study of polished surfaces. After deducting these impurities the analysis gave the following results:

Analysis of galenobismutite from Belzazzar mine

Constituent	Per cent	Calculation of ratios			
Lead (Pb)	23.93	0.116	0.149	149×1	1.03×1
Iron (Fe)	.39	.006			
Copper (Cu)	1.73	.027			
Antimony (Sb)	2.56	.021	.279	140×2	1.00×2
Bismuth (Bi)	53.59	.258			
Sulphur (S) (Calc.)	17.80	.555	.555	139×4	1.00×4

The ratios yield the usual formula, $PbBi_2S_4$ or $PbS.Bi_2S_3$. Such material as the galenobismutite has long been recognized as a characteristic mineral of rich gold ores in this region and has passed under the name "antimony" in the supposition that it was stibnite. These occurrences were probably in part galenobismutite and in part bismuthinite. A gray mineral resembling the galenobismutite was noted in small amount associated with pyrite and a little sphalerite in quartz in ore from the upper tunnel of the Granite State mine, Pearl district. This may be bismuthinite or galenobismutite. It was insufficient in amount for chemical examination.

MIARGYRITE (121)

Silver sulphantimonite, $Ag_2S.Sb_2S_3$. Monoclinic.

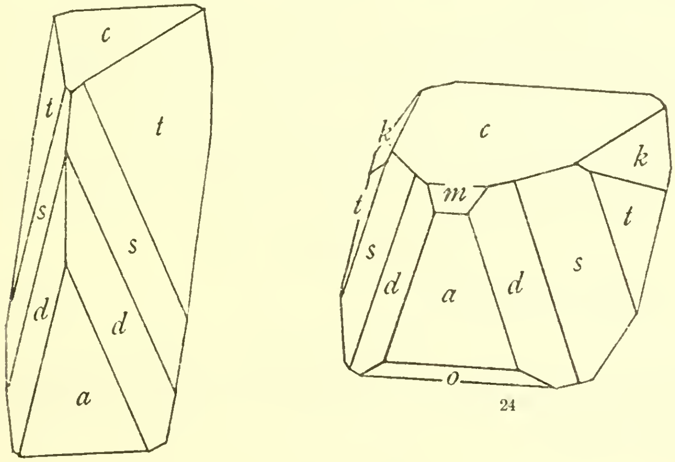
OWYHEE COUNTY

Miargyrite is a comparatively rare silver mineral which had not been identified from any American locality until Penfield found it in specimens from the Silver City district collected by Lindgren. The following description of the crystals from this locality is taken from

Penfield's report.[25] Apparently the mineral has been abundant in the ores of several of the mines, the ore of the Henrietta mine containing more miargyrite than pyrargyrite and proustite. In color the mineral is steel black with metallic luster and it gives a red streak. An analysis or a crystallographic examination is necessary to distinguish it from pyrargyrite. In the Henrietta ores it occurred as crusts of crystals on quartz often coated by white clay. The crystals commonly average less than 3mm. in diameter and are usually not well adapted for crystallographic measurement, since the majority of them are either dull, appearing as though they had been slightly corroded, or are striated. The habits are as shown in Figures 23 and 24 and the forms observed, which are the common and characteristic ones for the species, are as follows:

$a(100)$ $m(101)$ $t(111)$ $d(311)$
$c(001)$ $o(\bar{1}01)$ $s(211)$ $k(124)$

The basal plane *c* is generally striated parallel with its intersection with the orthodome *o*. The pyramids *d* and *s* occur in oscillatory combination, both with one another and with the orthopinacoid *a* and the pyramid *t*, and consequently are striated to such an extent that they appear as a rounding of the edges between *a* and *t* rather than as distinct faces. The faces lettered *k* are dull and give no distinct reflections but from their position and the direction of their intersection with adjoining faces it is assumed that the form has been correctly identified as the pyramid *k*(124) which is one of the common forms of the species.



23 24

Figs. 23–24.—Miargyrite. Henrietta mine, Owyhee County. After Penfield

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[25] U. S. Geol. Survey, 20th Ann. Rept., pt. 3, pp. 168–916, 1900.

Considering the character of the crystals the measurements recorded in the following table approximate as closely as can be expected to the values derived from the fundamental measurements of Lewis given in Dana's mineralogy.

Measurement of miargyrite from Henrietta mine

Angle	Measured	Calculated
	° ′	° ′
$c(001) \wedge a(100)$	98 00	98 37
	98 09	
	98 16	
$c(001) \wedge m(101)$	40 15	41 24
$c(001) \wedge o(\bar{1}01)$	48 07	48 21
$a(100) \wedge t(111)$	69 25	69 45
	69 24	
$t(111) \wedge s(211)$	13 ±	14 17

When roasted before the blowpipe on charcoal the mineral gives a coating of oxide of antimony and a globule of silver results from long continued heating.

Several specimens of ore from the Henrietta mine, which are preserved in the National Museum all show some crystals of miargytire. and a specimen of this mineral in the University of California mineral collection is labeled as from the Rising Star mine, which is in the Flint district. This last specimen was examined optically by Larsen[25a] who found it to be optically positive with 2V moderate; nearly opaque and with the lowest refractive index (α) greater than 2.72.

DUFRENOYSITE (126)

Lead sulpharsenite, $2PbS.As_2S_3$. Orthorhombic.

BLAINE COUNTY

Dufrenoysite is reported to occur in the Wood River district in considerable quantity with ores of lead.[26] No specimens have been seen by the writer.

BOISE COUNTY

This mineral is also reported to occur in the Crown Point vein in the Banner district.[26] Very few specimens of the rich ores of this vein have been preserved and none showing dufrenoysite have been available for examination.

[25a] Esper S. Larsen. U. S. Geol. Survey, Bull. 679, p. 110, 1921.

[26] Albert Williams, jr. Useful Minerals of the United States in U. S. Geol. Survey Mineral Resources for United States., 1887, p. 723, copied in U. S. Geol. Survey Bull. 624, p. 117, where the latter locality has apparently erroneously been changed to read Bonner County.

AIKINITE (138)

Copper lead sulphobismuthite, $Cu_2S.2PbS.Bi_2S_3$. Orthorhombic.

ADAMS COUNTY

A specimen from the Seven Devils Mining district labeled "SD 51, North Drift in R.R. tunnel, Seven Devils," is a mere fragment consisting largely of a white or light gray metallic mineral resembling bismuthinite, intergrown with cubes of pyrite in a gangue of white calcite and quartz. When the calcite was in part dissolved away by acid the gray mineral was found to consist of very indistinct flattened striated plates. By crushing the entire small specimen, picking out the quartz and pyrite as far as possible and running the balance through methylene iodide heavy solution a sample of one-fourth gram was obtained for analysis. The mineral gave a strong bismuth reaction with potassium iodide-sulphur mixture before the blowpipe and also gave qualitative reactions for lead and copper. The analysis, recalculated to 100 per cent after deducting 7.72 per cent of quartz and 5.40 per cent of pyrite gives the following percentages and ratios:

Analysis and ratios of bismuth mineral from the Seven Devils

Constituent	Per cent	Ratios		
Lead (Pb)	39. 54	0. 1909	0. 048 × 4	1. 00 × 4
Copper (Cu)	6. 20	. 0975	. 049 × 2	1. 02 × 2
Bismuth (Bi)	36. 58	. 1759	. 044 × 4	. 92 × 4
Sulphur (S)	(17. 68)	. 5513	. 050 × 11	1. 04×11
Total	100. 00			

These ratios give the formula $Pb_4Cu_2Bi_4S_{11}$ or $4PbS.Cu_2S.2Bi_2S_3$. Thus if the copper be considered cuprous it does not agree with the commonly given formula for aikinite. If the copper be assumed to be cupric the formula can be simplified to $3(Pb,Cu)S.\ Bi_2S_3$. The material was too scanty to definitely settle the exact nature of this material, the single analysis made upon impure and insufficient material being not dependable enough to base a new species upon although it is possible that a new mineral is here represented. This deserves further study upon more material. Until its nature is definitely settled it may best be referred to aikinite.

BOULANGERITE

Lead sulphantimonite, $5PbS.2Sb_2S_3$. Orthorhombic.

Within recent years boulangerite has been found to be a rather abundant constituent of ores, both in Idaho and elsewhere. Much of the fibrous material which has heretofore been called jamesonite is in reality boulangerite. The mineral occurs in lead-silver ores as an accessory constituent, having been found abundantly both in the Wood River district in Blaine County and in the Cocur d'Alene district in Shoshone County. A generalization, derived from the study of a large series of specimens of ores seems to be that stibnite is not stable in association with galena, the antimony sulphide tending to enter into combination in the form of a sulphosalt, and under the conditions obtaining in most ore deposits boulangerite is the most stable compound. The mineral often closely resembles stibnite and the various Idaho occurrences have usually been considered to be stibnite.

BLAINE COUNTY

Boulangerite has been identified in ores from the North Star, Independence, and Minnie Moore mines in the Hailey (Wood River, Mineral Hill, Ketchum) district. The ores of the North Star mine consist of an intimate mixture of galena, pyrite, sphalerite, chalcopyrite, pyrrhotite, and arsenopyrite in a gangue of quartz. Most of the specimens which the writer has examined show galena, dark brown rather coarsely crystalline sphalerite, pyrite, arsenopyrite, and boulangerite in a gangue of quartz or a carbonate of the ankerite group. The gray mineral which has heretofore been mistaken for stibnite is all boulangerite. This boulangerite seems to be a constant constituent of the ores. It has the usual steel gray color and metallic luster and exhibits the characteristic brownish rubbed streak. It occurs as compact parallel fibrous masses, as slender needles lining cavities, as tufted wool-like aggregates in cavities and as compact and slightly schistose massive forms with other sulphides, the massive variety evidently having been subjected to pressure. The boulangerite is commonly the youngest mineral in the veins and it often lines cavities or occurs between the crystals making up quartz combs. Upon analysis a sample containing some adhering quartz gav results tabulated in column 1 below. In column 2 the analysis is recalculated to 100 per cent after deducting gangue:

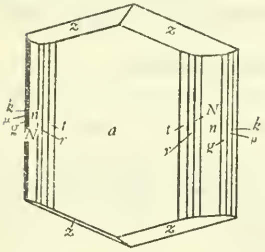

FIG. 25.—BOULANGERITE. INDEPENDENCE MINE, BLAINE COUNTY

Analysis of boulangerite from North Star mine

Constituent	Per cent	
	Original	Recalculated
Lead (Pb)	49.44	55.52
Silver (Ag)	Trace.	
Iron (Fe)	.38	.43
Antimony (Sb)	21.03	23.63
Arsenic (As)	.94	1.06
Sulphur (S)	17.24	19.36
Insoluble (quartz)	10.86	
Total	99.89	100.00

Specimens from the Independence mine consist of fibrous and columnar masses of boulangerite associated with galena or with pyrite in a quartz gangue. The boulangerite often has a felted or curved-fibrous structure and specimens 5 to 6 inches through may consist almost entirely of boulangerite. A sample of this material upon analysis gave the following results:

Analysis of boulangerite from Independence mine

Constituent	Per cent
Insoluble (quartz)	3. 58
Lead (Pb)	53. 79
Silver (Ag)	Trace.
Iron (Fe)	. 41
Antimony (Sb)	23. 83
Arsenic (As)	. 12
Sulphur (S)	18. 11
Total	99. 84

In small open joints which cut the massive ore from this mine rosettes of small crystals of boulangerite occur. They reach a maximum length of about 1 millimeter and are highly polished with metallic luster and light lead-gray color. They are all tabular parallel to the front pinacoid $a(100)$ and seem to possess a distinct cleavage parallel to this plane. Several of these crystals were measured on the 2-circle goniometer.

These crystals are all simple in habit, the dominant forms, with the orientation adopted, being the macropinacoid $a(100)$, the prism $n(120)$ and the pyramid $z(124)$ while several other prismatic forms occur as narrow faces, the form and habit of the crystals being as illustrated in Figure 25. The prismatic zone is strongly striated vertically.

Since the angles did not seem to be in entire agreement with those given for boulangerite, new axial ratios were calculated from the measurements as follows:

$a=0.5038$	$\log. a=9.70226$	$\log. p_o=10.13386$	$p_o=1.3620$
$c=.6862$	$\log. c=9.83645$	$\log. q_o=9.83645$	$q_o=.6862$

The measured angles are compared with the angles calculated from these constants as follows:

Measurements of boulangerite from Independence mine

Form		Symbol		Quality, description	Measured				Calculated			
					φ		ρ		φ		ρ	
No.	Letter	Miller	Gdt.		°	′	°	′	°	′	°	′
1	*a*	100	$\infty 0$	Good, striated	90	00	90	00	90	00	90	00
2	*N*	450	$\infty \frac{5}{4}$	Poor, striated	58	15	90	00	57	47	90	00
3	*n*	120	$\infty 2$	Good, striated	44	23	90	00	44	47	90	00
4	*g*	130	$\infty 3$	do	33	32	90	00	33	24	90	00
5		140	$\infty 4$	Medium, striated	27	50	90	00	26	22	90	00
6	*k*	180	$\infty 8$	Good, striated	13	33	90	00	13	55	90	00
7	*r*	210	2∞	do	75	13	90	00	75	51	90	00
8	*t*	310	3∞	do	79	44	90	00	80	28	90	00
9	(?)	5. 12. 0	$\frac{12}{5} \infty$	Falr, striated	38	11	90	00	39	34	90	00
10	*z*	124	$\frac{1}{4}\frac{1}{2}$	Good	44	47	25	48	44	47	25	48

A specimen from the Minnie Moore mine collected by D. F. Hewett shows a rosette of acicular crystals of boulangerite in a joint in altered wall rock from the vein associated with brown hisingerite.

A specimen from the Ontario group claims on Boyle Mountain in the Warm Springs Creek district contains fibrous massive boulangerite intergrown with arsenopyrite.

SHOSHONE COUNTY

Boulangerite occurs as a rather constant accessory constituent of the ores of the Gold Hunter mine at Mullan and at one time was described by the writer, erroneously, as a new species under the name mullanite.[27] It forms needles or fibrous masses imbedded in quartz and siderite and thin acicular needles or felted wool-like masses in small cavities in quartz which are lined with quartz or siderite crystals, the boulangerite needles frequently penetrating the crystals. The mineral is steel gray and the streak (rubbed) is brownish gray to brown. The specific gravity was determined to be 6.407. Upon analysis the mineral gave the results in the following table, the iron being due to siderite in microscopic rhombohedral crystals supported by being pinned through by the fine needles of boulangerite.

Analysis of boulangerite from Gold Hunter mine

Constituent	Per cent
Lead	53. 33
Iron	1. 47
Antimony	24. 67
Arsenic	. 64
Sulphur	18. 11
Total	98. 22

Boulangerite, formerly called stibnite, occurs as minute tufts of fibers or needles "in lead-silver ore of the Bluebird stage in one ore shoot'' in the Bunker Hill mine at Wardner.[28] Partial analysis made upon specimens of this material sent to the writer by Stanly A. Easton show it to be boulangerite. A fibrous lead-antimony mineral which is probably boulangerite was common as patches in quartz in ores of the Standard-Mammoth ore body between the 1,800 and 2,000 foot levels and a similar mineral occurred as subcolumnar and granular masses in galena in the ores of the Greenhill-Cleveland ore shoot in the same mine. Boulangerite occurs in the East Hecla vein in the Hecla mine in small amounts as a late deposit coating fractures in the ore.[29]

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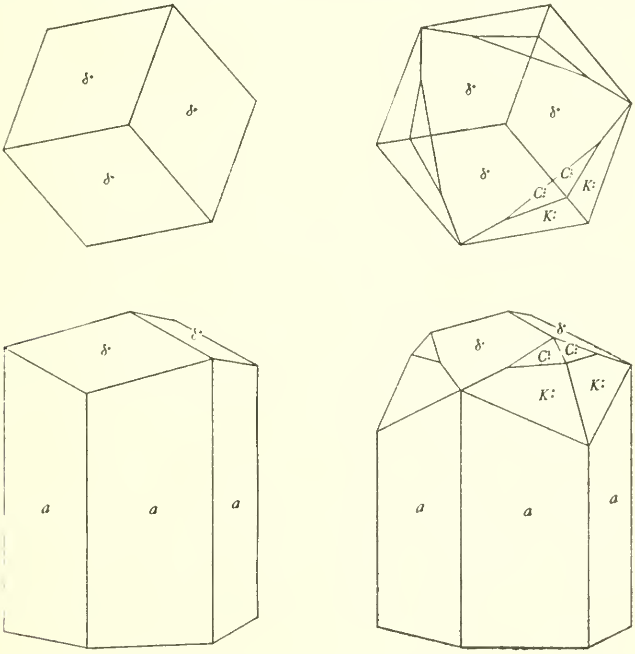
[27] Earl V. Shannon. Amer. Journ. Sci., vol. 44, p. 66, 1918. Much of the above data on boulangerite from Blaine County has also previously been published. See Proc. U. S. National Museum, No. 2351, vol. 58, pp. 589–607, and Amer. Journ. Sci., vol. 1, pp. 423–426, 1921.



26 27

FIGS. 26–27.—PYRARGYRITE. CRYSTALS RESTING ON MIARGYRITE. HENRIETTA MINE, OWYHEE COUNTY

PYRARGYRITE (144)

DARK RUBY SILVER

Silver sulphantimonite, $3Ag_2S.Sb_2S_3$. Hexagonal, rhombohedral.

Pyrargyrite, which is commonly called dark ruby silver, is a common mineral in the richer silver ores of Idaho. It is usually gray in color, with little suggestion of the red but when scratched it gives the characteristic red streak or powder. Some polybasite also has a red streak and has consequently been confused with pyrargyrite.

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[28] Oscar H. Hershey. Origin and distribution of ore in the Coeur d'Alene. Private publication, printed by Min. and Scientific Press, San Francisco, 1917, p. 24.

[29] Waldemar Lindgren. Personal communication, 1921.

BLAINE COUNTY

Pyrargyrite is reported to have occurred in rich ores of the Star mine at the head of Star Gulch 3 miles southwest of Hailey with galena and sphalerite in a gangue of quartz and calcite, and also in ores of the Smoky district.[30]

BOISE COUNTY

In the Idaho City district, on the Washington claim, 40 feet north of the gold vein, pyrargyrite occurred abundantly with stephanite in a quartz vein 8 inches to 4 feet in width. Near the surface these minerals were altered to cerargyrite.[31]

Pyrargyrite is an important ore mineral in the silver mines of the Banner district. Specimens from the tunnel level of the Banner mine show narrow seams of quartz, averaging 2 centimeters in width, cutting altered granite. The quartz has grown as combs of crystals from either wall and the spaces between the crystals are occupied by large grains of pyrargyrite associated with stephanite and dark brown sphalerite.

CUSTER COUNTY

Dark ruby silver occurs in small amount with cerargyrite, native silver and copper carbonate, in oxidized ore of the Skylark mine in the Bay Horse district and has been reported also from the General Custer mine, Yankee Fork district.[32]

ELMORE COUNTY

In the rich ores of the Atlanta lode, Atlanta district, pyrargyrite is one of the most abundant minerals, being second in importance only to stephanite. In a lease held by Landis & Co., in the old Monarch ground where some rich ore was encountered on the surface, the vein contained a streak 2½ inches wide of ruby silver with a parallel streak the same width of rusty quartz containing native silver.[33]

It occurred occasionally as distinct crystals but more frequently was in granular masses, either alone or mixed with stephanite (Cat. Nos. 51864 and 56534, U.S.N.M.) or disseminated in minute grains or larger bunches and stringers in granular quartz (Cat. No. 14759, U.S.N.M.), sometimes so abundantly as to give the quartz a dark color. Elsewhere it formed streaks near the walls of narrow quartz veins, the centers of which were brecciated and impregnated with stephanite, argentite, and stromeyerite (Cat. No. 31099, U.S.N.M.).

IDAHO COUNTY

Pyrargyrite is reported to occur in the Goodenough vein, Warren district, with sphalerite, pyrite, tetrahedrite, and arsenopyrite.[34]

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[30] Waldemar Lindgren. U. S. Geol. Survey, 20th Ann. Rept., pt. 3, pp. 199, 213.

[31] Waldemar Lindgren. 18th Ann. Rept., pt. 3, p. 689.

[32] J. B. Umpleby. U. S. Geol. Survey, Bull. 539, pp. 67, 85, 1913.

[33] Joshua E. Clayton. Trans. Am. Inst. Mining Eng., vol. 5, Feb., 1877, pp. 468–473

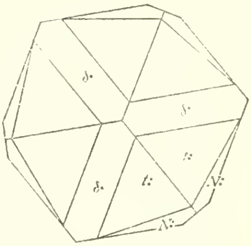
[34] Waldemar Lindgren. U. S. Geol. Survey, 20th Ann. Rept., pt. 3, p. 248, 1900.

LEMHI COUNTY

Steel gray films and fibers occur occasionally in the ores of the Junction district.[35]

OWYHEE COUNTY

Pyrargyrite is a common ore mineral in the Silver City and adjacent districts. In the Flint district grains of pyrargyrite 1 to 2 millimeters in diameter were noted in ore from the Rising Star mine, disseminated in white quartz with other silver minerals. In the De Lamar mine it was common in the silver stopes, and in crevices immediately adjacent to the "iron dike" nuggets of pyrargyrite, miargyrite, and argentite occur in soft streaks of whitish kaolin.[36] In a specimen from a stope in a raise in the east drift of the Silver City mine pyrargyrite occurs as irregular large grains loosely deposited upon crusts of quartz crystals, with irregular grains of fluorite. Specimens from the Henrietta mine collected by Lindgren showing abundant steel gray crystals of miargyrite attached to quartz and covered by white clay bear a few minute deep red transparent crystals of pyrargyrite. Several of these were measured on the 2-circle goniometer. Some of them are simple, showing only the prism (1010) with the rhombohedron (1122), while others show the forms (4151) and (4152). These crystals are illustrated in Figures 26 and 27. The angles measured are as follows:



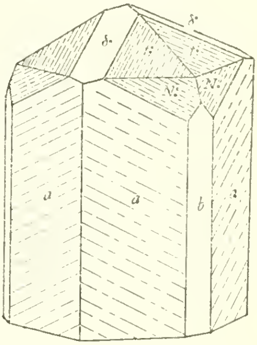


Fig. 28.—Pyrargyrite. California shaft. Silver City district, Owyhee County

Measurements of pyrargyrite from Henrietta mine

Form		Symbol		Quality, description	Measured		Calculated	
No.[a]	Letter	Miller	Gdt.		φ	ρ	φ	ρ
					° ′	° ′	° ′	° ′
12	a	$10\bar{1}0$	∞0	Very good	0 18	90 00	0 00	90 00
6	f'	$11\bar{2}2$	+½	Excellent	30 18	24 26	30 00	24 28
4	C:	$41\bar{5}1$	+41	Very good	10 56	67 22	10 53	67 18
3	e:	$41\bar{5}2$	+2½	Medium poor	11 06	50 26	10 53	50 17

[a] Number of faces measured.

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[35] J. B. Umpleby. U. S. Geol. Survey, Bull. 528, p. 78, 1913.

[36] Waldemar Lindgren. U. S. Geol. Survey, 20th Ann. Rept., pt. 3, p. 128.

A specimen from the California or Marguerite shaft on War Eagle Mountain, Silver City district, contains finely disseminated argentite, chalcopyrite, etc., forming streaks in white fine granular or flinty quartz. This contains small drusy cavities lined with quartz crystals, with occasional well-developed pyrargyrite crystals, 2 millimeters or more in size. One of these which was measured is illustrated in the drawing, Figure 28. The measurements obtained upon it are as follows:

Measurements of pyrargyrite, Marguerite mine

Form		Symbol		Quality, description	Observed				Calculated			
No.	Letter	Miller	Gdt.		φ		ρ		φ		ρ	
					°	′	°	′	°	′	°	′
1	*a*	$10\bar{1}0$	∞0	Poor	0	22	90	00	0	00	90	00
2	*b*	$11\bar{2}0$	∞	do	30	20	90	00	30	00	90	00
3	*f*·	$11\bar{2}2$	+½	Good	30	10	24	16	30	00	24	28
4	*N*:	$11.2.\overline{13}.2$	$+\frac{11}{2}$	Poor	8	24	72	25	8	13	72	34
5	*t*:	$41\bar{5}4$	+1¼	do	12	03	31	05	10	53	31	02

SHOSHONE COUNTY

Ruby silver, which occurs sparingly in the ore of the Yankee Boy mine on Big Creek and is reported from the Polaris mine, is probably in part pyrargyrite, as it is rather dark in color. Specimens showing thin films of pyrargyrite coating joints in galena were collected by the writer from the stope above the 2,000-foot level of the Standard-Mammoth ore shoot at Mace. This occurrence is interesting, as the pyrargyrite apparently represented a very last stage of the vein-forming activity, the earlier mineralizations here being very base and low grade and containing large quantities of pyrite, arsenopyrite, pyrrhotite, etc., and relatively little silver.

PROUSTITE (145)

Silver sulpharsenite, $3Ag_2S.As_2S_3$. Hexagonal, rhombohedral.

Proustite, commonly known as light ruby silver, is similar to pyrargyrite, differing in being lighter red in color and in having arsenic instead of antimony as an essential constituent. It is of rather frequent occurrence in silver ores in Idaho.

BLAINE COUNTY

In the Era district in the Ella mine at the head of Ella Canyon proustite occurs in small grains in the oxidized ores associated with argentite, cerargyrite, and tetrahedrite.[37] In the Hub mine, Lava Creek district, 2 miles southwest of Martin, proustite occurs with stephanite in a quartz-calcite gangue. The silver minerals occur as minute crystals embedded in the gangue material and intergrown with the pyrite, and also as narrow veinlets cutting across the sulphide ore.[38]

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[37] J. B. Umpleby. U. S. Geol. Survey, Prof. Paper 97, p. 121, 1917.

BOISE COUNTY

Ruby silver, probably proustite, has been reported as a rarity in ores of the Shamrock and Lincoln mines in the Pearl district.[39]

LEMHI COUNTY

Proustite occurs as small red crusts on ores from the Carmen Creek district, and is reported as occurring in ores of the Texas and Spring Mountain districts.[40]

OWYHEE COUNTY

In Owyhee County proustite has been found rather frequently in most mines. In the Henrietta mine it occurred but was not abundant, being replaced in the ores by miargyrite and pyrostilpnite. In the Poorman mine a remarkable occurrence of proustite is reported to have occurred about 100 feet below the surface. The mineral formed a solid mass weighing over 500 pounds, and it is stated that its surface showed roughly the planes and angles of a crystal. Upon being fractured it showed through the mass a uniform crystalline structure. A portion of this mass was sent to the Paris Exposition of 1867, where it was awarded a gold medal.[41] Lindgren states that if this is correct, and the testimony appears to be reliable, this constitutes one of the most remarkable occurrences of this mineral known.[42] D'Aligny [43] describes the material exhibited by Wells D. Walbridge, of Ruby City, as silver ores from the Poorman lode (No. 306), consisting of four large specimens of native silver, ruby silver, chloride and sulphuret of silver, valued at $5,000.

SHOSHONE COUNTY

In the Coeur d'Alene district proustite occurs in the Yankee Boy mine, and is reported from the Polaris and Big Creek mines on Big Creek near Kellogg. The ores of these mines consist mainly of highly argentiferous tetrahedrite with less galena and pyrite in a gangue of quartz and siderite. The proustite is rare in the vein proper, but occurs in thin films and as flattened and distorted crystals in joints in the slaty wall rocks adjacent to the veins.

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[38] J. B. Umpleby, U. S. Geol. Survey, Prof. Paper 97, p. 123, 1917.

[39] Waldemar Lindgren. U. S. Geol. Survey, 18th Ann. Rept., pt. 3, p. 713, 1897.

[40] J. B. Umpleby. U. S. Geol. Survey, Bull. 528, p. 78, 1913.

[41] J. Ross Browne. Mineral Resources of the United States for 1868, p. 523.

[42] Waldemar Lindgren. U. S. Geol. Survey, 20th Ann. Rept., pt. 3, p. 153, 1900.

[43] Henry F. Q. D'Aligny. Catalogue of minerals of the United States of America exhibited at the Paris Exposition. Paris, 1867, p. 12.

PYROSTILPNITE (146)

Silver sulphantimonite, $3Ag_2S.Sb_2S_3$. Monoclinic.

OWYHEE COUNTY

Pyrostilpnite, known also as fire blende, is identical with pyrargyrite in composition but differs in crystal form. It is an exceedingly rare mineral which has been identified by Penfield[44] as a single crystal associated with miargyrite from the Henrietta mine, Silver City district. This was fiery red in color and yielded characteristic blowpipe reactions for silver, antimony, and sulphur. It was about 1½ millimeters in greatest diameter and agreed exactly in habit with a specimen of the corresponding arsenic compound xanthoconite from Freiburg, Saxony, presented to the Brush collection by Prof. A. Weisbach and with the description and figure by Miers of xanthoconite from Markirch, Elsass. The faces were striated to such an extent that no reliable measurements could be obtained from them. While it was probably was not rare associated with the miargyrite of the Henrietta mine, almost no specimens from this mine have been preserved and no other specimen showing pyrostilpnite is known.

XANTHOCONITE (146a)

Silver sulpharsenite, $3Ag_2S.As_2S_3$. Monoclinic.

OWYHEE COUNTY

The rare silver mineral xanthoconite is identical with proustite in composition but differs in crystallization and is usually yellow to orange-red or brown in color. It is reported to have occurred in the rich ores of the Flint district associated with polybasite and stephanite.[45] None of the mineral was recognized in the few specimens of the rich ores from this district which have been available for examination. Browne was a Freiberg man, familiar with silver minerals, and his identification is probably to be relied upon.

OWYHEEITE

Lead silver sulphantimonite, $8PbS.2Ag_2S.5Sb_2S_3$. Orthorhombic.

OWYHEE COUNTY

A mineral making up a considerable portion of a specimen of silver ore from the Poorman lode, Silver City district, was described as a silver bearing variety of jamesonite[45a] and later was given the name owyheeite, it being evident that it was a distinct species.[46] The mineral occurs in rather large amount in a typical rather coarsely crystalline white vein quartz which is loose textured as from combs grown together from opposite sides of a narrow vein. Where cavities occur in the specimen they are bounded by plane faces of quartz crystals. The deposition of the owyheeite began before the quartz crystals had ceased to grow, as the latter contain variously oriented needles of the metallic mineral in their tips. The deposition of the sulphosalt continued after the cessation of growth by the quartz crystals until nearly all of the intercrystal spaces were solidly filled with the owyheeite. When the quartz is broken up prismatic crystals are loosened leaving lustrous molds in the owyheeite. The only other minerals in the specimen are rare stains of pyrargyrite, resinous yellow grains of sphalerite and small nests of sericite.

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[44] S. L. Penfield, quoted by Lindgren. U. S. Geol. Survey, 20th Ann. Rept. pt. 3, p. 169, 1900.

[45] J. Ross Browne. Mineral Resources of United States, 1868, p. 528.

[45a] Earl V. Shannon. Proc. U. S. Nat. Mus., vol. 58, pp. 601-604, 1920.

[46] Earl V. Shannon. American Mineralogist, vol. 6, pp. 82-83, 1921.

The owyheeite is very light gray to almost silver white on fresh fracture and the luster is metallic splendent. The masses are fine grained and show only a faint suggestion of fibrous structure to the eye. At the contact with the latest growth of quartz crystals the mineral is in distinct needles penetrating the quartz. Polished specimens, when examined microscopically with vertical illumination, show every gradation from wholly massive owyheeite to material made up of interlaced prismatic needles. Careful etching of the polished surfaces failed to indicate the presence of more than one mineral in the gray masses. In very rare and minute cavities in the quartz the owyheeite occurs in prismatic needles of microscopic size which are entirely too small for goniometric study. These needle-like crystals are very brittle, breaking across the elongation at the slightest touch in a manner indicating a well-defined cleavage in this direction. Upon exposure the mineral assumes a faintly yellow color. The hardness is about 2.5 and when rubbed upon paper the mark is gray like hard graphite but its streak upon unglazed porcelain is reddish brown.

The blowpipe characteristics of the mineral are the usual ones for sulphantimonites of lead. In the open tube it yields sulphur dioxide and a copious sublimate of white antimony oxide. In the closed tube fragments melt and yield a faint band having an upper ring of antimony oxide succeeded downward by light rings of yellow sulphur, red antimony oxysulphide, and black antimony sulphide.

The mineral is easily soluble in hot concentrated hydrochloric acid. Selected fragments of the owyheeite, separated from quartz, where analyzed with the results given below:

Analysis of owyheeite from Poorman mine

Constituent	Per cent	Ratios		
Lead (Pb)	40.77	0.197	0.205	0.041×5
Iron (Fe)	.46	.008		
Copper (Cu)	.75	.015	.084	.042×2
Silver (Ag)	7.40	.069		
Antimony (Sp)	30.61	.255	.255	.042×6
Sulphur (S)	20.81	.649	.649	.042×15

The ratios indicate the formula $Pb_5Ag_2Sb_6S_{15}$ or $5PbS.Ag_2S.3Sb_2S_3$. A mineral described as an argentiferous jamesonite from Nevada by Burton is probably also owyheeite and Foshag has recently found the mineral in a specimen from a third locality in Nevada, so that its occurrence is not confined to Idaho. It may be found in other specimens of the rich silver ores from the Poorman mine.

JAMESONITE (130)

Lead iron sulphantimonite, $4PbS.FeS.3Sb_2S_3$. Orthorhombic

For some years it has been the practice of many mineralogists to call all fibrous lead sulphantimonites not otherwise identified jamesonite. Recent investigations by Spencer and Schaller have shown that jamesonite, which contains iron as an essential ingredient and possesses a cleavage across the needles rendering them brittle, is a comparatively uncommon mineral. As mentioned above, much of what has heretofore been called jamesonite is really boulangerite. Most of the occurrences of jamesonite mentioned in Idaho are not certainly correct, the identification of the mineral being only tentative.

BLAINE COUNTY

Jamesonite has been reported to occur in the Reliance mine, Era district, associated with pyrite, galena, sphalerite, and chalcopyrite in a fine-grained quartz-chalcedony gangue.[47]

OWYHEE COUNTY

Specimens of altered rhyolite from the dump of the 800 foot level of the De Lamar mine have open cavities which contain radiating prismatic fibers up to 1 cm. long of a steel gray sulphantimonite. The fact that the fibers are brittle and break sharply across the elongation indicates that the mineral is either jamesonite or owyheeite. Similar needles occur imbedded in quartz crystals or projecting into open cavities of quartz of ore from the Rising Star mine, Flint district. These are associated with argentiferous tetrahedrite.

SHOSHONE COUNTY

A specimen of a fibrous sulphantimonite from the stopes above the 2,000-foot level of the Standard-Mammoth mine contained a fibrous sulphantimonite of lead which, upon partial analysis, yielded only 36.4 per cent of lead. This is probably jamesonite although boulangerite was common in this ore body.

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[47] J. B. Umpleby. U. S. Geol. Survey, Prof. Paper 97, p. 122, 1917.

TETRAHEDRITE (148)

Copper sulphantimonite, $5Cu_2S.2(Cu,Fe,Zn)S.2Sb_2S_3$. Isometric, tetrahedral.

The mineral tetrahedrite, commonly known as "gray copper," is of widespread occurrence in Idaho as an ore mineral, some mining districts having produced great quantities of ore in which it is the most prominent valuable constituent. It usually contains notable amounts of silver and its principal value is as a silver ore.

ADAMS COUNTY

Occasional bunches of tetrahedrite, locally called "copper glance," occur with chalcopyrite and small amounts of covellite, replacing andesite tuffs along a shear zone in the River Queen mine in the Seven Devils district.[48]

BLAINE COUNTY

Tetrahedrite is common in the richer lead-silver ores of the Wood River district, having been reported especially from the Quaker City, Jay Gould, Bullion, Argent, and other mines. In the Bellevue King mine it is said that a 2-foot streak of tetrahedrite was encountered. The mineral usually occurs in banded veins with coarse-grained galena and the gray copper often occupies the center of the vein. In the Buckhorn mine on Elkhorn Hill near Ketchum, in the upper tunnel, 175 feet from the surface, there was found a 2-foot vein of solid tetrahedrite ore containing from 180 to 200 ounces of silver a ton. Tetrahedrite is reported to have been mined from the Columbia, Pilgrim, and other mines in the Sawtooth district and at Soldier Mountain 9 miles north of Corral. A specimen of ore from the Golden Glow mine, Rosetta district, contains massive dark gray tetrahedrite, partly altered to bindhiemite, in quartzite.

BOISE COUNTY

Tetrahedrite, or a mineral of similar appearance, occurs occasionally as a constituent of sulphide-bearing gold ores in the several mining districts in Boise County. It has been noted in small masses in specimens of ores from the Carroll-Driscoll mine associated with sphalerite, chalcopyrite, and a little barite. Specimens from the Overlook mine, Diana Mining Co., Pioneerville district, contain masses of tetrahedrite up to 1 inch in diameter in quartz ore with galena, sphalerite, and pyrite.

BONNER COUNTY

Tetrahedrite is the principal ore mineral of the Little Joe or Keystone mine in the Blacktail district on the west shore of Lake Pend Oreille. The mineral occurs in a gangue of manganiferous siderite. Tetrahedrite is also the principal mineral in the silver ores of the Weber and other mines south of Lakeview on the south end of the lake.

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[48] D. C. Livingston and F. B. Laney Idaho Bur. Mines and Geol. Bull, 1, p. 40, 1920.

CUSTER COUNTY

Tetrahedrite is exceedingly rare in the Alder Creek district, having been observed only in small particles in some of the partly oxidized ore from the Copper Bullion tunnel.[49] Tetrahedrite forms the principal valuable mineral in the ores of the Bayhorse district, which has perhaps produced more tetrahedrite ore than any area of similar size in the world. Ore, in which tetrahedrite is the only valuable metallic mineral, to the value of $6,250,000 has been mined from the four principal mines of the district.[50] The tetrahedrite is practically always massive, dark gray, and with splendent luster on fresh fracture, which becomes metallic upon moderate exposure. The three principal mines producing tetrahedrite ore are the Ramshorn (product, $3,000,000), Sky Lark, and Silver Bell. The ore bodies are filled fissures in slates. The typical ore consists of about three-fourths siderite and tetrahedrite makes up about one-third of the remainder or about 8 per cent of the vein filling. A little arsenopyrite, galena, and chalcopyrite accompany the tetrahedrite. Sometimes a central vein an inch or two wide, of tetrahedrite, is bordered on either side by a layer of chalcopyrite a half inch or more in width; (Cat. No. 56521, U.S.N.M.). Other specimens show large masses of pure tetrahedrite from the Ramshorn mine, in siderite. In small vugs in the ore crystals of tetrahedrite occur associated with crystals of arsenopyrite and siderite. The crystals are usually coated with a mossy crust of minute crystals of chalcopyrite. A specimen from the Hoosier mine, Bay Horse, contains masses of this mineral, 1 to 2 inches in diameter, in granular pyrite. Specimens from the Skylark mine contain masses of tetrahedrite up to 4 inches through in oxidized gangue and smaller veins and masses partly altered to cuprite, malachite, azurite. A specimen from the No. 3 tunnel, Silver Bell mine, contains some residual masses in oxidized material. The tetrahedrite is sometimes altered to crusts of yellow-green or yellow waxy bindheimite, associated with azurite and velvety tufts of malachite (Cat. No. 51863, U.S.N.M.). Specimens from the Bull of The Woods, Bullion, and other mines are similarly largely massive tetrahedrite partly altered to malachite and azurite (Cat. No. 56518, U.S.N.M.).

A specimen of very pure tetrahedrite from the Ramshorn mine was analyzed for Umpleby by R. C. Wells. The results of this analysis, together with the ratios, are given in the following table:

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[49] J. B. Umpleby. U. S. Geol. Survey, Prof. Paper 97, p. 55, 1917.

[50] J. B. Umpleby. U. S. Geol. Survey, Bull. 539, pp. 34–35, 1913.

Analysis and ratios of tetrahedrite, Ramshorn mine

Constituent	Per cent	Ratios			
Gangue	0.08				
Copper	33.39	0.525	0.707	.059×12	.98×12
Silver	4.86	.045			
Iron	4.64	.083			
Zinc	3.53	.054			
Manganese	.01	-----			
Nickel	Trace.	-----			
Antimony	25.22	.210	.231	.058×4	.97×4
Arsenic	1.46	.019			
Bismuth	.34	.002			
Sulphur	25.74	.803	.803	.062×13	1.03×13

The ratios agree rather well with the formula proposed by Wherry and Foshag, namely $R_{12}Sb_4S_{13}$ or $R_{10}'R''_2Sb_4S_{13}$, which expanded is $5R'_2S.2R''S.2Sb_2S_3$. The iron and zinc are, however, present slightly in excess of the total bivalent bases required, so that it is not necessary to assume the presence of any bivalent copper, the formula consequently being written

$$5(Cu,Ag)_2S.2(Fe,Zn)S.2Sb_2S_3.$$

The ratio of silver to copper is 1 : 13.3 and that of zinc to iron is 1 : 1.54, or very nearly 2 : 3. The analytical ratios agree somewhat better with the more complex formula

$$10(Cu,Ag)_2S.5(Fe,Zn)S.4Sb_2S_3,$$

which may be further expanded to show the relation between iron and zinc to

$$10(Cu,Ag)_2S.3FeS.2ZnS.4Sb_2S_3.$$

Such a complex formula is not ordinarily justified by a single analysis and is here presented only because a tetrahedrite from Shoshone County gave identical results as discussed below.

ELMORE COUNTY

Tetrahedrite occurs in small quantity in the Monarch mine, Atlanta district.

IDAHO COUNTY

Tetrahedrite occurs as silver-rich grains and masses with free gold, ruby silver, and pyrite in the Little Giant, Rescue, Goodenough, and other veins of the Warren district, and also as a constituent of silver-gold ores of the Big Buffalo, Jumbo, and other mines of the Buffalo Hump district. It probably occurs in gold ores of other mining districts of the county. A specimen of ore from the Black Pine mine, Elk City district, contains grains of "gray copper" sparingly disseminated in quartz with galena, sphalerite, pyrite, and free gold.

LEMHI COUNTY

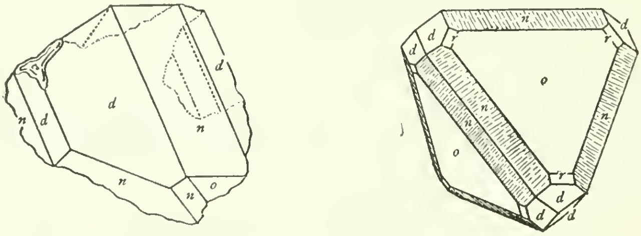
Gray copper ore containing 1.9 per cent of silver occurs as irregular patches and grains in ores of the Blue Wing district. The mineral occurs in quartz with sphalerite, hübnerite, and molybdenite.[51]

OWYHEE COUNTY

In Owyhee County tetrahedrite is common in ores of the Flint district, associated with other silver-bearing minerals, as masses and grains in white quartz.

SHOSHONE COUNTY

Tetrahedrite is common in Shoshone County, in the Coeur d'Alene district, being perhaps the only primary silver-bearing silver mineral of the silver-lead ores. Its best development is in the ores of the so-called "dry belt" veins, which are narrow-filled fissures in shales of the Wallace formation, the Yankee Boy mine on Big Creek, and the Polaris mine in Polaris Gulch being the most exploited deposits of this type. The tetrahedrite, which is the most prominent ore mineral, is usually massive, although small crystals have been noted in vugs in ore from the Yankee Boy mine. The gangue is either quartz or coarse buff manganiferous siderite and the veins also contain some pyrite, specular hematite, galena, and a little proustite or pyrargyrite. The mineral from these veins is usually highly argentiferous and is mined as a silver ore. There are a number of veins of the same general type between Kellogg and Wallace. The tetrahedrite from the Polaris mine is said to be arsenic and mercury bearing. Closed tube tests did not indicate the presence of either of these elements in tetrahedrite from the Yankee Boy mine.



29 30

Figs. 29-30.—Tetrahedrite. Hypotheek mine, Shoshone County

Tetrahedrite occurs also in many of the lead-silver ores, having been especially noted in the Standard-Mammoth, Hercules, and Gold Hunter mines. There is reason to believe that the silver content of the galena ores is more or less proportional to their tetrahedrite content and the mineral probably occurs in microscopic grains in many ores in which it can not be recognized with the eye. Specimens of argentiferous galena from the Bunker Hill mine showing 0.08 and 0.09 per cent of silver, upon assay, proved to contain microscopic grains of tetrahedrite when polished and examined under a metallographic microscope as did a specimen from the Hercules mine containing 0.108 per cent of silver.[52] The Caledonia mine at Wardner contained bodies, often of considerable size, consisting almost entirely of massive tetrahedrite, in quartzite, sometimes with included irregular patches of chalcopyrite, although there was very little tetrahedrite in the galena ore from other parts of the mine. Ore mined from these silver-rich tetrahedrite bodies sometimes carried 3,000 ounces to the ton.

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[51] J. B. Umpleby. U. S. Geol. Survey, Bull. 528, p. 111, 1913.

Tetrahedrite has been noted in the Hypotheek mine at Kingston in a calcite gangue with pyrite and arsenopyrite and also as crystals along cracks in quartz. The crystals reach 5 mm. in diameter and show bright faces which yield excellent reflections of the signal. The development is such, however, that the tetrahedral symmetry is not apparent. A typically developed crystal is shown in Figure 29 and the most completely developed and symmetrical crystal measured is shown in somewhat idealized form in Figure 30. The forms recognized are *o* (111), *n* (211), *d* (110), and *r* (332). This tetrahedrite was analyzed, the analysis giving the following results and ratios, after having been recalculated to 100 per cent after deducting quartz:

Analysis and ratios of tetrahedrite from Hypotheek mine

(E. V. Shannon, analyst)

Constituent	Per cent	Ratios			
Copper	37.70	0.593	0.744	0.063×12	1.00×12
Silver	Trace.	------			
Iron	5.13	.092			
Zinc	3.87	.059			
Arsenic	Trace.	------	.223	.057× 4	.92× 4
Antimony	26.81	.223			
Sulphur	26.49	.826	.826	.064×13	1.03×13
Total	100.00				

The ratios agree fairly well with Wherry and Foshag's formula, but, like the preceding, this formula is satisfied without assuming the presence of any cupric copper and the analysis is best represented by the formula derived for the mineral from the Ramshorn mine, namely $10Cu_2S.3FeS.2ZnS.4Sb_2S_3$. The practical absence of silver is noteworthy, as is the absence of more than a trace of arsenic, since the mineral occurs in a vein containing abundant arsenopyrite.

Tetrahedrite has been noted from other veins of the Pine Creek Basin, as the Big 8, Lookout-Mountain, Carbonate, Northern Light, and Bobbie Anderson, and in all of these veins it seems to be practically nonargentiferous. Similar silver-free tetrahedrite has also been noted in small amount in the ore of the Wisconsin claim east of Kellogg, where it is later than the quartz-ankerite-pyrrhotite mineralization in which it fills seams.

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[52] F. N. Guild. A microscopic study of the silver ores and their associated minerals. Economic Geology vol. 12, pp. 305–306, 1917.

WASHINGTON COUNTY

The silver-bearing ores of the Mineral district, chief among which are the Silver Bell, Maria, and Black Hawk, with numerous lesser prospects, all contain notable amounts of tetrahedrite associated with galena, sphalerite, pyrite, etc.[53]

TENNANTITE (149)

Copper sulpharsenite, $5Cu_2S.2(Cu,Fe,Zn)S.2As_2S_3$. Isometric, tetrahedral.

BEAR LAKE COUNTY

Tennantite, like tetrahedrite, is commonly known as gray copper. The two minerals are very similar in all their properties, the principal difference being in the relative proportions of arsenic and antimony, those containing arsenic in excess of antimony being classified as tennantite. A "gray copper" from the Humming Bird mine, in Paris Canyon near Paris in the St. Charles district, contains more arsenic than antimony and hence is referable to tennantite.[53a] The mineral, which is massive, occurs in a breccia composed of quartz and jasper and is partly altered to azurite and malachite. It is quite possible that, were the gray copper ores from all localities in the State submitted to a careful chemical examination more of them would be found to be predominantly arsenical.

STEPHANITE (153)

Silver sulphantimonite, $5Ag_2S.Sb_2S_3$. Orthorhombic, hemimorphic.

The black silver mineral commonly known as antimonial silver or brittle silver has been a prominent ore mineral in much of the high-grade silver ore mined in the State.

BLAINE COUNTY

In the Lava Creek district stephanite occurs as small disseminated grains in quartz and intergrown with pyrite and also with proustite in veinlets cutting the sulphide ore.[54]

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[53] Waldemar Lindgren. U. S. Geol. Survey, 22d Ann. Rept., pt. 2, pp. 754–755, 1901.

[53a] R. W. Richards. U. S. Geol. Survey, Bull. 470, p. 179, 1911.

[54] J. B. Umpleby. U. S. Geol. Survey, Prof. Paper 97, p. 123, 1917.

BOISE COUNTY

Stephanite occurred abundantly in quartz with pyrargyrite and cerargyrite in a silver vein which was found 40 feet north of the gold vein on the Washington claim, Idaho City district.[55] In a specimen of ore from this locality the mineral, which is brilliant gray with good cleavage, occurs plastered around quartz crystals in minute combs. In specimens from the tunnel level, Banner mine, Banner district, fine dark steel gray masses which are probably stephanite occur with pyrargyrite, coarse granular sphalerite, and some pyrite, between crystals of interlocking quartz combs in narrow veins in altered granite.

ELMORE COUNTY

In Elmore County stephanite has been the most abundant and important ore mineral in the rich silver ores of the Atlanta district. The mineral occurs as granular, imperfectly crystalline, and columnar black masses associated with a less amount of pyrargyrite in comb quartz. Often the pyrargyrite forms lines along the sides of narrow veins while the centers are filled with stephanite (Cat. No. 51864, U.S.N.M.). In some specimens the stephanite occurs as grains with pyrargyrite in coarse granular galena. (Cat. No. 30199, U.S.N.M.). In the Atlanta lode stephanite was the most abundant ore in the bonanza deposits; next in quantity came pyrargyrite, while argentite, stromeyerite, and native silver were present in relatively small quantities. "The rich streak of black stephanite and ruby silver varied in width from 1 foot to 6 or 7 feet, alongside which was a band of similar width of payable ore containing free gold with disseminated silver minerals, making the workable vein from 2 to 15 feet wide and extending in length underground in the Monarch and Buffalo claims nearly 2,000 feet on the course of the lode."[56]

OWYHEE COUNTY

Stephanite is prominent in the ores of the Flint district, being reported by J. Ross Browne early in the history of the district. It is to be found in specimens collected from the Rising Star and other mines within recent years.

POLYBASITE (156)

Silver sulphantimonite, $8Ag_2S.Sb_2S_3$. Monoclinic, perihexagonal.

Polybasite is probably a common mineral in many of the silver ores of the State and has been reported from a number of districts. It is to be noted, however, that most of the identifications of the mineral are made upon visual characteristics only and are in need of confirmation by exact methods. The mineral often has a red streak or powder and many occurrences might be identified as pyrargyrite on this property.

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[55] Waldemar Lindgren. 18th Ann. Rept. U. S. Geol. Survey, pt. 3, pp. 688-689, 1897.

[56] Joshua E. Clayton. Trans. Amer. Inst. Min Eng., vol. 5, Feb. 1877, pp. 468-473.

BOISE COUNTY

In Boise County polybasite is reported to occur commonly as a constituent of rich silver ores in the Banner district where it is associated with pyrargyrite, cerargyrite, and native silver.

BONNER COUNTY

Polybasite has been identified by Edward Sampson, of the United States Geological Survey, in a specimen of rich ore from the Blue Bird mine near Talache on the north side of Blacktail Mountain on the west shore of Lake Pend d'Oreille. The mineral occurs as a thin platy layer along joints in the ore, associated with native silver. The plates show no crystal outlines, but exhibit tabular faces of the basal pinacoid on which the triangular rulings characteristic of the mineral are visible. The streak of the mineral is black but the powder under the miscroscope is very slightly translucent with a suggestion of red color.

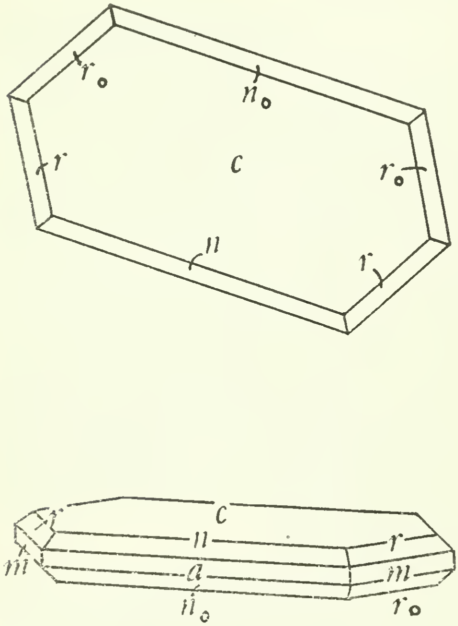

FIG. 31.—POLYBASITE. TABULAR CRYSTAL FROM RICH GULCH MINE, SILVER CITY DISTRICY, OWYHEE COUNTY

ELMORE COUNTY

Polybasite occurred commonly but in minor amount as a constituent of rich silver ores of the Atlanta lode, Atlanta district.

OWYHEE COUNTY

In Owyhee County polybasite is probably common in the silver ores of the Silver City, De Lamar, and Flint districts. In ore from the De Lamar mine it occurs as abundant dark gray, steel gray masses up to 1 cm. in diameter, showing distinct cleavage, in quartz (Cat. No. 74623, U.S.N.M.). In the Leviathan mine polybasite is associated with pyrargyrite and stephanite. In similar form the mineral has been abundant in many of the rich silver mines of the Silver City district, particularly the Poorman mine. It is reported that in 1864 a specimen of pure polybasite weighing 6 pounds and containing 75 per cent of silver from the Morning Star discovery shaft was on exhibition in a Portland bank with a shipment of silver bullion.[57] This mineral is also common in the ores of the Flint district in massive form in quartz. Except for their cleavage these masses resemble tetrahedrite. This mineral has been noted in the ore from the the Rising Star mine, and is reported to have occurred with stephanite and xanthoconite in the rich ores first mined in the district.[58] A specimen from a vein in drift 500 feet north, 2,650 feet from the portal of the Rich Gulch mine, west slope of Florida Mountain, Silver City district, shows a narrow quartz vein averaging 1 cm. in width inclosed in greatly sericitized rock. The quartz is drusy along the center and the druses are lined with polybasite in minute but sharp and brilliant hexagonal thin tabular crystals. One of these was measured and found to have the forms and development shown in Figure 31, the forms being $a(100)$, $m(110)$, $c(001)$, $r(112)$, $r_o(\bar{1}12)$, $n(101)$, n_o $(\bar{1}01)$. These are iron-black in color and have hexagonal and triangular markings on the basal pinacoid. They have a distinctly red streak like that of pyrargyrite.

SHOSHONE COUNTY

A gray mineral resembling polybasite has been noted in quartz of ore from the Pilot mine, Murray, associated with gold and silver tellurides and native gold.

PEARCEITE

Basic silver sulpharsenite, $8Ag_2S.As_2S_3$. Monoclinic, perihexagonal.

BONNER COUNTY

Pearceite, the arsenic analogue of polybasite, has been recognized in ore from the Conjecture mine, Lakeview district, south of Lake Pend d'Oreille. Several stages of mineralization were recognized in this vein. The earlier mineralization consists of manganiferous ankerite and sphalerite which is replaced by galena and tetrahedrite. The galena is partly replaced by pearceite and both are later replaced by anglesite.[59]

ENARGITE (158)

Copper sulpharsenite, $Cu_2S.4CuS.As_2S_3$. Orthorhombic.

CUSTER COUNTY

Enargite occurs in massive form as a primary constituent of some of the ores on Dickens Hill, in the Yankee Fork district.[60] It has been noted only in small amount in a few specimens.

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[57] Portland Daily Oregonian, Dec. 13, 1864. Capt. John Mullan, Miners and Travelers Guide to Oregon-Washington, etc. New York, 1865, p. 106.

[58] J. Ross Browne. Mineral Resources of United States, 1868, p. 528.

[59] Edward Sampson. Oral communication, 1922.

[60] J. B. Umpleby. U. S. Geol. Survey, Bull. 539, p. 52, 1913.

HALITE (166)

ROCK SALT

Sodium chloride, NaCl. Isometric.

BANNOCK COUNTY

Salt has been obtained for many years from saturated salt brines which are obtained from brine springs which seep from barren patches of stony gravel in the valley bottoms on Rock Creek, Crow Creek, and Tygee Valley. White salt often forms a crust about these springs which are probably underlain by extensive deposits of rock salt. In deepening a spring in Crow Creek Valley, 38 miles northeast of Montpelier, rock salt was encountered 6 feet below the surface. This was penetrated to a depth of 20 feet without reaching the bottom of the deposit. This salt is exceptionally pure sodium chloride.[61]

OWYHEE COUNTY

Sodium chloride occurs in small amount mixed with epsomite, gypsum, nitrates, etc., in nitrate prospects on Jump Creek, Sucker Creek, and in adjoining regions southeast of Homedale, Oreg.[62]

CERARGYRITE (169)

HORN SILVER

Silver chloride, AgCl. Isometric.

Cerargyrite is, in Idaho as in most other silver producing States, the most important and in many mines the only important silver mineral in the oxidized ores. Unless present in considerable amount it is very inconspicuous and is liable to be unnoticed in rusty quartzose ores in which it is present in some abundance. Ores which are leached and cellular from oxidation yet which contain high values in silver are commonly called chloride ores, even though the cerargyrite may never be present in visible grains. There is a tendency which has been noted among Idaho miners to refer to as "chlorides" any yellowish or greenish yellow coloration in the oxidized ores. This is incorrect as the silver chloride is rarely yellow. These so called "chlorides" are usually ocherous bindheimite, an antimonate of lead although pyromorphite is also called chloride ore.

Where present cerargyrite is usually in grains, globules, or thin crusts on quartz mixed with limonite. It may be recognized by its softness and sectility and by its property of turning grayish lavender in color when exposed to sunlight.

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[61] C. L. Breger. U. S. Geol. Survey, Bull. 430, p. 555, 1910.

[62] G. R. Mansfield. U. S. Geol. Survey, Bull. 620, pp. 19–44, 1916.

BLAINE COUNTY

Cerargyrite has been found in small grains and films with other silver minerals and cerusite in the ores of the Ella mine, in Ella Canyon in the Era district. In the Wood River districts it was common in the ores near the surface in many small veins and with native silver and sulphides of silver in the Silver Star mine.

BOISE COUNTY

In the Idaho City district a vein on the Washington claim parallel to the gold vein carried predominant silver as cerargyrite near the surface and as stephanite and ruby silver in depth. In the Banner district cerargyrite occurred abundantly in the oxidized portions of the rich silver veins.

CUSTER COUNTY

Cerargyrite occurs in the Whale mine with free gold, in the Montana mine in films and grains in drusy iron-stained quartz (Cat. No. 56526, U.S.N.M.) and in the oxidized portions of the General Custer, Charles Dickens, and possibly other mines. In the Bay Horse district it occurs in the Beardsley, Pacific, and Silver Bell mines with argentite; in the Red Bird Mine in sand carbonate; and in the River View mine in cerusite and in cellular iron-stained quartz (Cat. No. 56522, U.S.N.M.).

ELMORE COUNTY

Cerargyrite is reported to have occurred in some abundance in surface ores of the Monarch and other mines of the Atlanta district.

IDAHO COUNTY

Small amounts of cerargyrite have been reported from veins in the Florence and Warren districts.

LEMHI COUNTY

Cerargyrite has been mined from the districts in the southeastern portion of the county, where small particles occur in ores formed by the oxidation of argentiferous galena. It occurs also as a secondary product in the Carmen Creek mine and in the Blue Wing district.[63]

OWYHEE COUNTY

Cerargyrite was probably present in the surface ores of all silver mines of this county. In the Silver City district it was especially abundant in heavily iron-stained quartz in the Hornsilver mine. In the St. Clair mine it occurred with moderately coarse galena in cellular iron-stained quartz (Cat. No. 5473, U.S.N.M.) and in the War Eagle it formed films in iron-stained cellular portions of quartz containing finely disseminated argentite. In the Poorman mine it is common as films in granular quartz and in spongy quartz containing steaks of disseminated argentite. In the bonanza surface ores of the Poorman lode remarkable amounts of cerargyrite were found. The mineral occurred in sheets along both walls of the vein and slabs a foot square and one-sixteenth of an inch thick could be peeled off. Masses weighing many pounds were frequently obtained.[64] It was often well crystallized and in some cases the crystals were half an inch across. These were mostly cubes and cuboctahedrons but occasionally with other planes and in twins consisting of interpenetrating cubes, the angles of one projecting from the faces of the other.[65] Exceptionally fine specimens from this remarkable occurrence have fortunately found their way into the Yale University collection and thus have been preserved. Horn silver occurred in the De Lamar and adjacent mines and in ore from the Laxley mine, South Mountain district, the chloride occurs in altered spongy matrix with malachite and bindheimite stains.

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[63] J. B. Umpleby. U. S. Geol. Survey, Bull. 528, p. 76, 1913.

SHOSHONE COUNTY

Cerargyrite has never been definitely identified from any locality in the Coeur d'Alene district, although it is quite probably present in the richer oxidized lead silver ores. Miners in this district often call any yellowish colored mineral "chlorides," particularly ocherous bindheimite, pyromorphite, and in one case, greenish scorodite.

EMBOLITE (170)

BROMIDE OF SILVER

Silver chloride-bromide, AgCl. AgBr. Isometric.

The chlorobromide of silver which usually occurs in soft wax-like films, grains, or crusts resembling cerargyrite or horn silver, but having a yellow or yellow-green color, has not been certainly identified in Idaho. Bromide of silver has been reported from a number of localities, as, for example, the Little Giant vein in the Warren district in Idaho County,[66] but no specimens have been available for examination and it is not known whether the mineral is embolite or bromyrite, both of which are commonly called bromide of silver. Bromides of silver are reported by miners and prospectors from many districts, but these reports are not reliable, as western miners use the term "bromides" indiscriminately to indicate any greenish or bluish colored silver bearing material. Such "bromides" are in most cases earthy cerargyrite-bearing oxidized ores stained by copper compounds.

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[64] J. Ross Browne. Mineral Resources of United States, 1867, p. 523.

[65] E. S. Dana. System of Mineralogy, p. 158, 1895.

[66] Waldemar Lindgren. U. S. Geol. Survey, 20th. Annual Report, pt. 3, p. 246, 1900.

BROMYRITE

BROMIDE OF SILVER

Silver bromide, AgBr. Isometric.

The remarks given above under embolite apply equally well to the chlorine-free silver bromide, bromyrite, the two minerals being similar in all their properties. While bromyrite probably has been present in some of the rich oxidized silver ores of the State it has not been definitely identified and no specimens have been available for identification.

IODYRITE (173)

IODIDE OF SILVER

Silver Iodide, AgI. Hexagonal, hemimorphic.

Like the bromides of silver, silver iodide has occasionally been reported to occur in oxidized silver ores from Idaho,[67] but no specimens have been available for examination. The mineral is similar to cerargyrite and bromyrite in general properties and, since it has been found abundantly in Nevada, it probably occurred also in cerargyrite ores in Idaho.

FLUORITE (175)

FLUORSPAR

Calcium fluoride, CaF_2. Isometric.

No noteworthy deposits of fluorspar are known in Idaho, the occurrence of this mineral being limited to the ores of a few districts where it forms an unimportant accessory gangue material.

CUSTER COUNTY

Fluorite occurs in wide distribution in the Alder Creek or Mackay (White Knob) district in the contact metamorphic copper deposits and in the lime silicate rock near them. Chunks weighing several pounds are present in the dumps from the big quarry of the Empire mine.[67a] This is in the form of broad crystalline masses with perfect octahedral cleavage and varying from colorless to faintly purple. It is mixed with some copper silicates. Other specimens are pale purple cleavable masses containing small yellow-green garnet crystals. Fluorite is also common as purple grains in garnet-magnetite rock from 500 feet down the east slope of White Knob and ore from the Tiger claim contains pale green fluorite cleavages associated with bornite and copper silicates in garnet rock.

Near the head of the North Fork of Lost River fluorite occurs as pale green octahedral crystals up to 1 cm. in diameter in a narrow vein of cellular quartz in andesite. On Summit Creek near where the Ketchum-Mackay road crosses the divide fluorite occurs as colorless to white octahedral crystals with platy pseudomorphous quartz in talus slopes composed of Ordovician slate.

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[67] J. B. Umpleby. U. S. Geol. Survey, Prof. Paper 97, p. 53, 1917.

[67a] Reported as identified by W. P. Blake in specimens of ore from the "Boise Region." Oregon Daily Times, Nov. 28, 1864. Capt. John Mullan, Miners and Travelers Guide, New York, 1865, p. 108.

Specimens of oxidized ore from the Pacific mine, Bay Horse district, have small colorless to white cubic crystals resting upon crusts of calamine. These were examined optically and found to be isotropic with an index of refraction of 1.437 ± .002. These properties identify the mineral as fluorite. This occurrence is interesting as the fluorite is a very late deposit having formed subsequent to the crystallization of the calamine.

In the Stanley Basin district on Little Casino Creek the bedrock contains a system of north-south fissures containing quartz and a considerable amount of fluorite along one of which is a gouge seam carrying gold.[68]

IDAHO COUNTY

Purple fluorite has been reported to occur in very fine intergrowth with quartz in a large low-grade pyritic gold lode at the Independence prospect in the Big Creek district. The best description of the deposit available makes no mention of the mineral.

OWYHEE COUNTY

A specimen of ore from a stope in the east drift of the Silver City mine, Silver City district, consists of a comb of quartz crystals bearing loosely attached large grains of pyrargyrite and some small white grains, most of which are irregular, although some appear cubic. These seem later in age than the pyrargyrite. This white mineral was examined optically by A. Rodolfo Martinez, who found it to be isotropic with a refractive index of 1.434. It is thus shown to be fluorite.

A specimen from a tunnel on the south side of Long Gulch below the Blaine tunnel, Silver City district, shows octahedral crystals of pale lavender fluorite up to 3 mm. in diameter resting upon adularia crystals.

LAWRENCITE (178)

Ferrous chloride, $FeCl_2$.

Lawrencite or ferrous iron chloride is a soft green to brownish-green substance which is known to occur only in meteoric iron. It exudes from freshly cut or broken surfaces of meteorites and oxidizes almost immediately to brown rust. This compound was abundantly present in the meteoric iron which was found in a gold placer on Hayden Creek, Lemhi County.[69]

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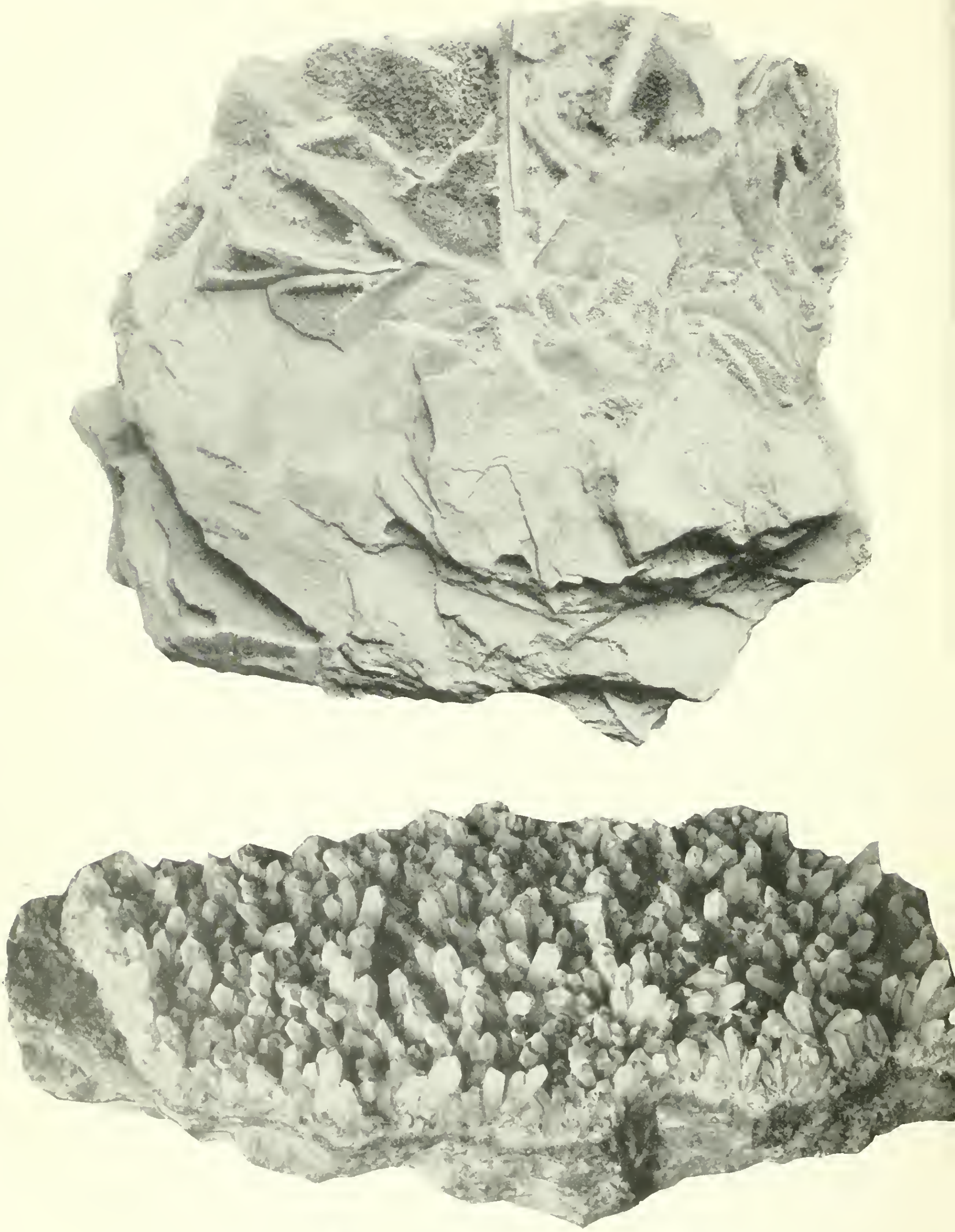
[68] J. B. Umpleby and D. C. Livingston. Idaho Bur. Mines and Geol. Bull. 3, p. 15, 1920.

[69] William Earl Hidden. Amer. Journ. Sci., vol. 9, p. 367, 1900.



Pseudomorphous and Crystallized Quartz

For description of plate see page 179

QUARTZ (210)

Silicon dioxide, SiO_2 Hexagonal Rhombohedral.

The mineral quartz, under which are included many varieties, including chalcedony, is an exceedingly common mineral and occurs very widely distributed in Idaho as elsewhere. The several varieties are discussed separately below under the several varietal names, in accordance with the following outline:

- A. Phenocrystalline varieties.
    - *a.* Common quartz, massive.
    - *b.* Rock crystal.
    - *c.* Amethyst.
    - *d.* Pseudomorphous.
- B. Cryptocrystalline varieties.
    - *e.* Chalcedony and agate.
    - *f.* Jasper.

Numerous other varieties of this mineral are recognized but they are not known to occur in good specimens in Idaho.

A. PHENOCRYSTALLINE VARIETIES

a. COMMON QUARTZ

MILKY QUARTZ, BULL QUARTZ, VEIN QUARTZ, GREASY QUARTZ.

Common massive quartz occurs throughout the State in veins and masses in rocks of all kinds, both as a gangue in metal bearing veins and as large deposits which are not known to contain any valuable metal. It varies in color from clean milky white, as for example in the gold veins of many districts in Idaho County, to bluish, or gray varieties, which pass under the miners name of "bull quartz." Entirely similar massive quartz occurs in considerable masses in pegmatites and in grains in granites and other igneous rocks. When these rocks disintegrate the quartz, being chemically the most stable constituent, remains behind in the form of waterworn grains and most sand is made up of such quartz grains. Consolidation of the sand gives rise to extensive formations of sandstone, also consisting essentially of more or less pure quartz, and by further metamorphism the sandstone is converted to quartzite, much of which is comparable in purity to the massive quartz of veins.

b. ROCK CRYSTAL

Under this head are included all the forms of colorless quartz which occur in distinct crystals. Small crystals of quartz occur in very wide distribution. The following occurrences have been noted.

Boise County.—Small crystals occasionally occur in open spaces in the gangue of the gold veins. A specimen of sericitized and pyritized porphyry from the Gold Hill mine dump, Quartzburg district, contains grayish phenocrysts of quartz which are rounded dihexagonal pyramids.

Custer County.—Euhedral doubly terminated crystals of quartz up to an inch or more in length occur embedded in siderite of ores of the Bay Horse district. These are sometimes somewhat milky and show zonal growth lines.[70] Near Challis quartz occurs in small amount coating platy (argentine) calcite and as spherulitic and spindle-shaped microscopic grains associated with ptilolite.[71] In the cirque at the head of Wildhorse Canyon at the eastern base of Hyndman Peak quartz occurs in crusts of clear transparent crystals lining many hollow veins in quartzite and gneiss. In basaltic lavas at many places in the upper valley of Lost River clear transparent quartz crystals line chalcedony geodes weathered out of the lava. These crystal-lined geodes are sometimes a foot in diameter.

Elmore County.—Vuggy quartz in veins of the Vishnu mine, Rocky Bar district, contains small crystals of quartz.

Owyhee County.—The gangue of the silver veins of the Silver City and adjacent districts in Owyhee county contains large amounts of quartz which is in part crystalline, in part chalcedonic and, in the De Lamar district, pseudomorphous, as described below. Numerous cavities and vugs occur in the ores and these are frequently lined with druses or larger crystals of transparent quartz, frequently intimately associated with ore minerals (pl. 3, lower). Fine crystals forming a continuous crust are to be found on the Blaine tunnel dump, Silver City district, and the Banner vein on Long Gulch, ¾ mile south of Silver City, contains numerous vugs lined with beautiful quartz crystals. A specimen from the Silver City mine consisting of a quartz-adularia intergrowth contains cavities lined with transparent colorless quartz crystals 3 to 5 mm. long which are prisms terminated by only three faces of one rhombohedron. Crystals of this same habit occur also in ore from the Mahogany mine (Cat. No. 14776, U.S.N.M.). Much of the pseudomorphous quartz from the De Lamar mine contains drusy quartz in minute crystals.

Lemhi County.—Fine druses of small quartz crystals have been seen coating galena in ore from the Pittsburg-Idaho mine, Gilmore district.

Shoshone County.—Fine sparkling specimens of drusy quartz coating chalcopyrite occur in the ore of the Empire (Horst-Powell) mine on the Little North Fork of the Coeur d'Alene River.

c. AMETHYST

Amethyst is essentially the same as rock crystal except that the crystals are colored purple, probably by small amounts of manganese. Amethystine quartz crystals have been noted in Idaho lining chalcedony geodes weathered from Tertiary basalts in the area covered by the Hailey quadrangle in Blaine County, especially on Pole Creek, a tributary to Little Wood River and in Custer County in Low Hills, near the Junction of the North Fork of Lost River with the main stream. The amethysts are rare, most of the geodes containing colorless crystals, and no deeply colored stones have been seen. Occasionally clear quartz crystals have an interior phantom crystal outline in pale amethyst.

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[70] J. B. Umpleby. U. S. Geol. Survey, Bull. 539, pl. 7, 1913.

[71] Clarence S. Ross and Earl V. Shannon. Proc. U. S. Nat. Museum, vol. 64, Art. 19, 1923.

d. PSEUDOMORPHOUS QUARTZ

HACKLY QUARTZ

Owyhee County.—The De Lamar, Webfoot, Chautauqua, and other veins in the same vicinity are all distinguished by the universal presence of a laminated quartz which is clearly of pseudomorphic origin. Occasionally there is some of the more massive flinty variety, but the laminated variety prevails from the croppings of the Big Reef and Garfield to the lowest level of the De Lamar mine. This laminated quartz forms a cellular network of thin and straight intersecting laminae of quartz. These meshes generally consist of a narrow median line adjoined on both sides by quartz, projecting as minute crystals on the surface of the laminae. The angles of intersection of the latter do not appear to follow any certain law. In some cases the outside of the laminae may be smooth and the inside only covered by the projecting points of crystals (pl. 3, upper); moreover the inside of these pseudomorphs is usually chambered by thin laminae, coated by comb quartz on both sides. Under the microscope these ores show intermingled coarser and finer quartz. The coarser part shows grains from 0.1 to 0.2 mm. in diameter, which have a decided tendency to crystal form though the influence of other individuals has prevented its perfect development. With higher magnifying power the fine grained material also dissolves into similar quartz mosaic. Both are mixed, the finer aggregate forming lamellar or triangular areas separated by coarser masses. Valencianite in abundant and minute crystals of rhombic form was identified without doubt in the quartz from the Chautauqua tunnel. It has not yet been discovered in that from the De Lamar mine.[72] Such hackly pseudomorphs have been found in precious metal veins in other areas, particularly in the Jarbidge district, Nevada. The structure seems quite certainly pseudomorphous after calcite of the peculiar tabular habit, parallel to the basal pinacoid. A specimen consisting of thick tabular plates of calcite making up a cellular aggregate was collected by Lindgren from the Owyhee shaft. The structure of this specimen is entirely analogous to that of some specimens of the pseudomorphous quartz. Typical argentine calcite having the platy structure and pearly luster is also present in a specimen from a tunnel dump on the south side of Long Gulch below the Blaine tunnel.

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[72] Waldemar Lindgren. U. S. Geol. Survey, 20th Ann. Rept., pt. 3, p. 170.

B. CRYPTOCRYSTALLINE VARIETIES

e. CHALCEDONY

Chalcedony is essentially the same as agate, except in that agates usually are more or less highly colored by included impurities, most frequently iron oxide. The chalcedony occurs in Idaho occasionally in veins but more frequently in cavities in basic igneous rocks.

Blaine County.—Translucent white or bluish chalcedony occurs in the Tertiary basalts in many places in the Hailey Quadrangle and adjacent regions and many of the lava hills are strewn with nodules and fragments of translucent chalcedony, usually white but sometimes colored by the presence of included iron oxide. Many of the irregular or rounded lumps have originally filled amygdaloid cavities in lava. Usually the first lining of the cavity has been calcite followed by the chalcedonic silica and the nodules show on their outer surface the gash-like molds of the acute rhombohedral crystals of calcite. Sometimes the masses are solid chalcedony with a concentrically banded structure, but more frequently they are hollow, sometimes with a botryoidal inner surface, but more frequently with a lining of quartz crystals, usually colorless but occasionally amethystine.

Custer County.—Chalcedony occurs in the lava areas of Custer County in the same manner as in Blaine County, especially near the North Fork of Lost River. Specimens of the rare zeolite, mordenite, from near Challis have a crust of chalcedony between the mordenite and the inclosing rock and nodules of chalcedony occur in the area. Cherty silica referable to chalcedony occurs in some limestones in the vicinity of Mackay.

Owyhee County.—Chalcedony occurs in lavas and a dense flinty chalcedonic silica occurs in some of the silver veins as a gangue mineral. A brownish radially fibrous variety occurs in ores of the Oro Fino mine. A specimen from the new ore shoot, De Lamar mine, consists of fine grained gray chalcedonic silica and a specimen from the Summercamp tunnel, De Lamar district, consists of dense very fine grained chalcedonic silica with lusterless fracture with pyrite replacing rhyolite.

Lemhi County.—Chalcedonic silica forms a gangue material in veins of the Parker Mountain district.

Valley County.—Chalcedonic silica replacing limestone forms the principal gangue of the cinnabar deposits of the Yellow Pine quicksilver district.[72a]

f. JASPER

Fine grained siliceous material heavily impregnated and colored by iron oxides which may correctly be called jasper, occurs at a number of places in Idaho.

Custer County.—Jasper commonly occurs in the lavas in the same areas which contain abundant chalcedony nodules, usually as veinlets and stringers. In the Alder Creek (Mackay) district much of the ore contains red and yellow ferrugineous jasper which is associated with indefinite copper silicates allied to chrysocolla. Nodules of brown jasper surrounded by crusts of chloropal have been sent to the National Museum by D. C. L. Kirtley from Challis.

Bear Lake County.—The possibility of a new copper ore-jasper gem or ornamental stone from the Humming Bird mine, in Paris Canyon, near Montpelier, has been considered. The constituent minerals are quartz with a very fine red dust pigment, and malachite. Under the microscope the quartz is seen to be granular, with close fitting grains, and is dusted full with minute red specks, probably hematite. The malachite is in bright green grains and masses with a radial fibrous and occasional spherulitic crystallization. The quartz incloses numerous small grains or buhrs of malachite bristling with needles. In the hand specimen the rock is bright jaspery red with dark green splotches throughout. The quartz is close grained and tough and takes a good polish. The malachite is softer though sufficiently hard to be polished along with the quartz. The contrast between the two colors is pleasing and for use in small ornaments, scarf pins, brooches, etc., the rock would serve well.[73]

Blaine County.—Jasper of the usual red and brown colors is common in Tertiary lavas, having been especially noted in the area east of Little Wood River near the southern boundary of the Hailey topographic sheet.

Fremont County.—A jaspery material forms the principal gangue material in the ores of the Old Scott mine in the Skull Canyon district. Specimens which have been examined show galena crystals up to 1 cm. in diameter isolated in yellow to brownish-red jasper.[74]

Washington County.—Jasper occurs as a gangue of manganese ores on Snake River 20 miles below Huntington.[75].

[72a] E. S. Larsen and D. C. Livingston. U. S. Geol. Survey, Bull. 715, pp. 73-83, 1920.

[73] Douglas B. Sterrett. U. S. Geol. Survey, Mineral Resources 1909, pt. 2, p. 804.

[74] J. B. Umpleby. Prof. Paper, 97, U. S. Geol. Survey, p. 119, 1917.

[75] D. C. Livingston. Univ. of Idaho, vol. 14, Bull. 2, pp. 32-33, 1919.

TRIDYMITE (211)

Silicon dioxide, SiO_2 Hexagonal.

CLARK COUNTY

The hexagonal form of silica, tridymite, is probably a more common mineral of lavas than is usually supposed, since it is usually recognizable only with the aid of a microscope. This mineral was found by Dr. E. S. Larsen to make up a considerable proportion of a number of specimens of rhyolitic lavas collected by H. T. Stearns in the vicinity of Libbys Hot Springs west of Dubois.

OPAL (212)

Silicon dioxide, usually with some water. Amorphous.

Opal ranging from brown to white opaque common opal, through various kinds of semiopal to fine precious opal has been found at a number of localities in Idaho, the principal occurrences being those noted below.

BOISE COUNTY

Sandstone cemented by fire opal has been collected from Neocene lake beds on both sides of Moore Creek at Idaho City.[76]

CUSTER COUNTY

Silica in the form of opal is abundant in miscroscopic grains in the copper silicate ore of the Alder Creek (Mackay) district. It is easily recognized in index solutions by its isotropism and low index of refraction.[77]

KOOTENAI COUNTY

Specimens, some of large size, of common opal obtained from near Setters, in the Spokane Valley between Spokane and Coeur d' Alene City, have been sent to the National Museum by Henry Fair, of Spokane. The material ranges from translucent to almost transparent and is yellow and greenish yellow to resinous brown in color. There is also some nearly opaque white opal in the lot. Nothing is known regarding the occurrence of this material.

LATAH COUNTY

In August, 1890, fine opal was found in digging a well near Whelan, 20 miles from Colfax, Wash., near Moscow, Idaho, and almost on the line between Idaho and Washington. It occurred more or less plentifully, and the last 4 feet of the rock contained cavities filled with precious opal. This opal occurs in a basalt in which most if not all of the feldspar and pyroxene as well as the groundmass seem to be altered. Buildings were erected and the locality named Gem City. The total yield of the mines during the summer and fall of 1891 amounted to over $5,000. The material is stated to have been fine, in many respects equal to the best material from the Hungarian or Australian mines. A gem, weighing 3½ carats, from this district was held at the rather extravagant figure of $500, partly perhaps on account of its American origin, and a rough mass of 2 ounces for $1,200. The deposits apparently were worked mainly on the Washington side of the line, but it is reported that in that year two companies were working on the Idaho side in Latah County.[78]

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[76] Waldemar Lindgren. U. S. Geol. Survey, 18th Annual Report, pt. 3, p. 665, 1897.

[77] J. B. Umpleby. U. S. Geol. Survey, Prof. Paper 97, p. 54, 1917.

It is reported that, in 1893, the North America Gem and Opal Mining Co., which operated the mines at Moscow, did no work owing to litigation.[79] There is little further mention of any work done on these deposits until 1904 when the mines were reported reopened.[80] No subsequent production has been reported, although it was later stated that in Latah and adjoining counties precious opal of the finest quality that has been found on this continent occurs near Salmon River as nodules in a very hard trachytic rock resembling the rock in which opal is found in Hungary. A single stone from this locality was worth $1,000.[81] A report based on the Washington side of the area states that the country is rolling meadow land adapted to the growing of wheat and that relatively little attention was paid to the possibilities of gem mining. The dumps contain piles of vesicular basalt, which is evidently part of a flow covering large areas in this region. Some of the rock is partly weathered and of a gray color but the fresh rock is grayish black and hard. In places hyaline opal occurs, filling vesicles and seams in the rock; and in places patches of precious opal can be found by breaking considerable rock. In places precious opal was found thickly scattered through the rock and some very fine gem opal was obtained.[82]

Some very good specimens of dark gray opalized wood have been seen from near Kendrick.

LEMHI COUNTY

Homogeneous masses of flinty common opal of various colors, including yellow, flesh pink, and black have been sent to the National Museum from May, a post office in Lemhi County, Idaho.

Opals were discovered in Lemhi County in 1902 on Panther Creek on the west side of the valley about 6 miles below its head and at an altitude of 7,000 feet. Here a large dike of porphyry runs parallel to the creek for nearly a mile and a half, forming a ledge partly covered with overwash from the mountain slope, but in places outcropping several feet high. The width is approximately 150 feet and the rock is full of opals of all sorts—milky, blue, green, brown, pink, etc., and among them some perfectly transparent fire or flame opal. Many of the masses are large, but to obtain good sized stones from them is difficult as the opals are very brittle and the rock is very hard. The locator obtained one stone of 60 carats which showed green reflections and a brown opal of 150 carats, but otherwise no good stones above 10 carats weight. The opal here is largely of the glassy variety with broad flames of color, but it is fragile and not well suited for jewelry. There is a large proportion of loss by breakage.[83] Umpleby mentions this locality as on Panther Creek in the eastern part of the Gravel Range district. He states that the opal occurs as linings in the vesicles of rhyolite flows but that precious opal does not appear to be present in commercial quantities.[84]

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[78] George F. Kunz. U. S. Geol. Survey, Mineral Resources of United States, 1892, p. 776.

[79] George F. Kunz. U. S. Geol. Survey, Mineral Resources of United States, 1893, p. 698.

[80] George F. Kunz. U. S. Geol. Survey, Mineral Resources, 1904, p. 956.

[81] George F. Kunz. Ann. N. Y. Acad. Sci., vol. 21, pp. 214-215, 1912.

[82] Douglas B. Sterrett. U. S. Geol. Survey, Mineral Resources, 1910, pt. 2, p .874.

LINCOLN COUNTY

Very fine specimens of very well preserved opalized wood are widely distributed in collections labeled as from Clover Creek, Lincoln County. The material is buff to yellow and black in color and is remarkable for the perfect preservation of the grain and original structure. Specimens of polished cross sections preserved in the National Museum are shown in plate 4. No data are available as to the occurrence of this material, which was originally collected by Otto Uhrlaub, of Bliss. Dr. Frank H. Knowlton reports that the wood is all of a dicotyledonous tree, quite certainly oak, and is probably late Tertiary in age. It is quite possible that the material is from Miocene lake sediments.

OWYHEE COUNTY

Opal has long been known to occur in Owyhee County. In 1893 it was said that the Owyhee opal mines were situated on section 13, township 1 north, range 4 west, Boise meridian, about 3 miles from Snake River in Owyhee County. The work done on the mine amounted to about 8 months work for 2 men. The opal taken out amounted to about 7,000 carats in the rough, varying from transparent fire opal to the finest noble white opal; but nearly all of this was either given away or poorly marketed. The opals were said to occur in a nearly vertical dark andesite dike about 25 feet wide which outcropped for a distance of 750 feet. In the center this contained a layer of very hard jasper 4 to 5 feet wide on each side of which the opals occurred in seams and flat pockets. The

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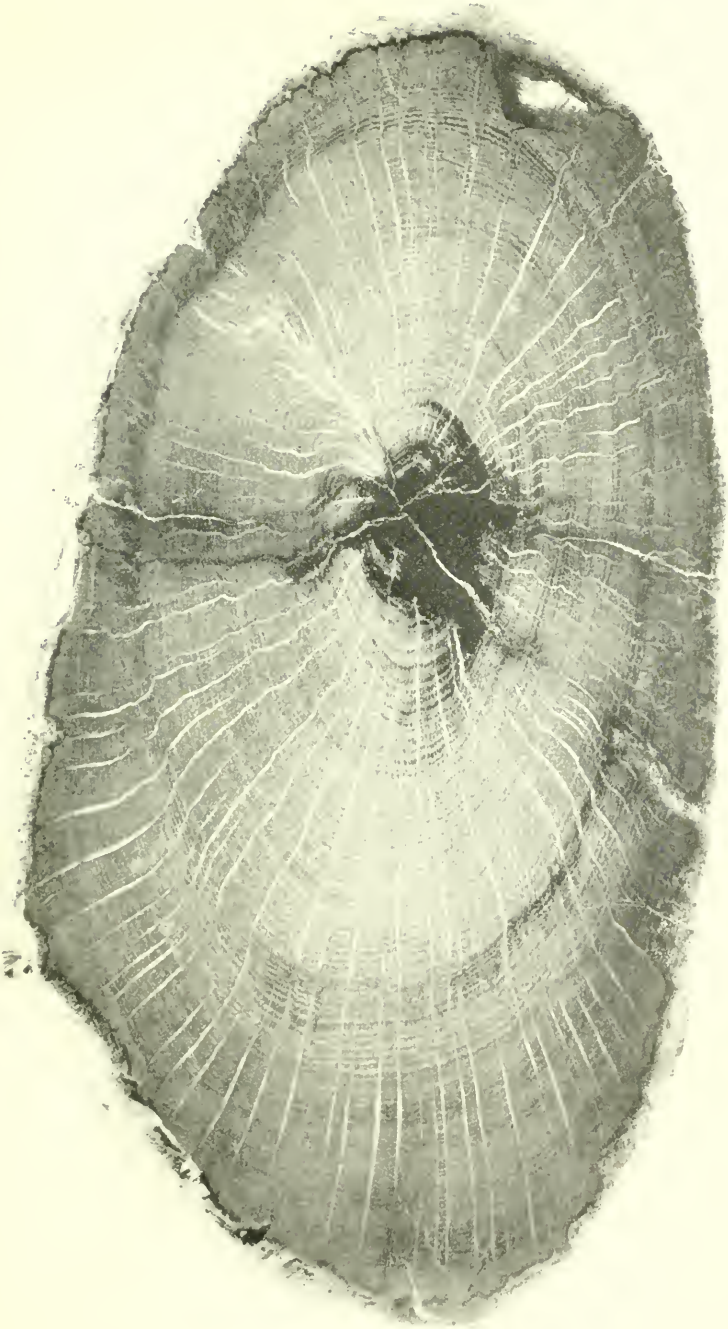
[83] Geo. F. Kunz. Mineral Resources, United States Geol. Survey, 1902, p. 853.

[84] Joseph B. Umpleby. U. S. Geol. Survey, Bull. 528, p. 174, 1913.



OPALIZED OAK WOOD

FOR DESCRIPTION OF PLATE SEE PAGE 184

opals had been found for a distance of 250 feet on the surface and the greatest depth reached in the open cuts was 20 feet. North of and parallel with this ledge was another, 8 feet wide, traced for 50 feet, from which 1,000 carats of good opals were obtained.[84a] The deposits have been briefly mentioned by Lindgren, Drake, and Schrader.[85] They were visited by Sterrett in 1910, when no work was in progress on any of them. He gives a very complete description of the deposits which is repeated below.[86]

Deposits have been opened on Squaw Creek and along the Caldwell-Rockville road about 2 miles east of south of Sommer camp. The deposit in the valley of Squaw Creek below the junction with Little Squaw Creek is situated in a small rounded hill about 1 mile above the ranch of Jim Keith. The elevation is about 3,500 feet above sea level and that of the mountains about 1,000 feet higher. The country is treeless, and low hills in the valley are covered only with sage brush and a small quantity of grass. A few small pits have been made on the summit of the hill and on the south side, cutting into the partially disintegrated basalt in which the opals occur. The basalt is highly vesicular, and under the microscope is found to be composed chiefly of lath-shaped crystals of labradorite, augite, and a brownish glass. The basalt is a portion of a flow which partly fills the canyon of Squaw Creek and rests on rhyolite and rhyolite tuff, the most important formation of the region. The partially disintegrated basalt breaks up fairly easy and is removed from the pits in large blocks. These blocks are broken up and the opal picked out. The opal occurs as amygdaloid in the steam holes and cavities in the basalt. The greater part of the cavities contain no opal, and only a part of the opal is of the precious variety, much of it being milky white or colorless. In some of the blocks of basalt broken into, the opal is plentiful and much of it has a fine play of colors. Most of the opal is in small pieces and large pieces of precious opal are rare. Some of the vesicles are filled with chalcedony and opal. Fragments of chalcedony and chalcedony with white opal 2 inches across were observed loose in the soil of the hill. Some of this material is banded both with curved bands and straight onyx bands. Similar specimens of chalcedony and white opal were seen in other places in the valley.

One of the larger mines, 3 miles west of Enterprise, contained two sets of workings on different sides of a draw or valley and from 35 to 65 feet above the bottom of the draw. The principal workings are on the west side and consist of several open cuts, the largest about 50 feet long and 25 feet deep and a tunnel 40 feet long. The other openings are about 150 yards to the northeast diagonally across the draw and consist of open cuts.

[84a] Geo. F. Kunz. U. S. Geol. Survey, Mineral Resources United States, 1893, p. 698.

[85] Silver City folio (No. 104), Geol. Atlas United States, U. S. Geol. Survey, 1904.

[86] Douglas B. Sterrett. U. S. Geol. Survey, Mineral Resources of United States, 1910, p. 872–874.

The opal deposits are in whitish chalklike decomposed rhyolite in which occur inclusions of blocks and rounded masses of gray to brown glassy perlitic ryholite. The perlitic rhyolite appears to be the same as the inclosing decomposed rhyolite but has not undergone alteration. A weathered yellowish fine porphyry bed occurs over the opal bearing rhyolite outcropping as a hard stratum. The formations have a gentle northerly dip and the rhyolite can be recognized at numerous places by its light-colored outcrop. The opal occurs in seams and veinlets, filling cracks and joints, as a filling in a brecciated fracture zone, and in nodular masses, both in the altered rhyolite and in the perlite. White and milky opal was plentiful around the dumps and a few small chips of precious opal were seen. Judging from the extent of the work done it is probable that valuable opal was found.

At another opal deposit about 2 miles east of south of Sommer camp and 4 miles west of Enterprise, about half a dozen pits have been made within 200 yards of one another, which range in size from 4 to 20 feet in depth and about the same in width. They are in a bed of partly decomposed whitish rhyolite interbedded with brownish glassy rhyolite. The formations are gently folded and the rhyolite outcrops at several places to the south along the road on the hill above. The beds have an aggregate north dip. Other prospects were opened on some of the upper outcrops of the rhyolite. Considerable chalcedony and white, milky, and bluish opal were seen on the dumps around the pits. White opal and translucent gray chalcedony are banded together in some specimens like onyx. Very little precious opal was seen around the old openings.

A number of specimens of opal labeled as from 3 miles west of Enterprise are preserved in the National Museum. The opal occurs in a black highly vesicular lava in which only a small proportion of the cavities are filled with opal. Apparently a soft ferric silicate, chloropal or a related mineral first lined or partly filled the cavities after which the opal was deposited. In some cases it appears as though a carbonate, since removed, preceded the opal.

Fossil bones collected from sandstone near Opaline at an elevation of 2,400 feet were encrusted with opal and some of their cavities contained fire opal. The bones were identified by Prof. O. C. Marsh as *Protohippus* of Pliocene age.[87]

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[87] Waldemar Lindgren. U. S. Geol. Survey, 20th. Ann. Rept., pt. 3, p. 99, 1900.

VALENTINITE (216)

Antimony trioxide, Sb_2O_3. Orthorhom.

SHOSHONE COUNTY

The antimony oxide valentinite occurs sparingly in the ores of the Stanley antimony mine in Gorge Gulch above Burke in the Coeur d'Alene district in the form of drusy coatings and crusts on stibnite and quartz. Although these crusts are very thin they often cover several square inches of surface. Those which rest on quartz are pale brown in color while the ones on stibnite are usually olive green. The luster is waxy and the mineral looks like cerargyrite or embolite. Valentinite may also occur in the earthy oxidation products which are common near the outcrops of the Coeur d'Alene antimony and other antimony veins on Pine Creek.

MOLYBDITE

Hydrous ferric molybdate, $Fe_2O_3 .3MoO_3 .7\frac{1}{2}H_2O$. Orthorhombic.

ADAMS COUNTY

Molybdite has been reported from the Peacock claim, Seven Devils district, where it occurred as an olive green earthy substance associated with powellite in a specimen consisting mainly of garnet and bornite.[88] Livingston and Laney [89] state that molybdite occurs sparingly in the contact metamorphic copper ores as an alteration product of molybdenite. Melville regarded the molybdite associated with the powellite as secondary after the calcium molybdate and derived from it by the action of carbonated waters.

BOUNDARY COUNTY

Molybdite is abundant in good specimens as thick silky pale yellow films and crusts coating quartz which contains molybdenite from veins in granite 21 miles by trail southwest of Porthill. Specimens of this material were shown the writer by Frank L. Hess, of the United States Geological Survey.

CUSTER COUNTY

A little molybdite has been noted as a yellow ocherous stain associated with molybdenite and powellite in quartz in specimens reported to be from the Bay Horse district.

ELMORE COUNTY

Bright yellow molybdite occurs as an alteration product of molybdenite on granite in a specimen sent to the National Museum by William R. Decker from Pine, Elmore County.

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[88] W. H. Melville. Amer. Jour. Sci., vol. 41, p. 138, 1891.

[89] D. C. Livingston and F. B. Laney. Idaho Bur. Geology and Mines, Bull. 1, p. 67, 1920.

LEMHI COUNTY

Molybdite occurs sparingly as an alteration product of molybdenite near the surface in the hubnerite-bearing tungsten vein of the Ima Mine, Blue Wing district.

TUNGSTITE (220)

Tungsten trioxide, $WO_3.H_2O$. Orthorhombic.

Tungstite is a mineral commonly formed in small amounts in the oxidation of other tungsten minerals. It is commonly bright yellow in color and earthy in appearance and is known by the common name of tungstic ocher.

LEMHI COUNTY

Tungstite occurs in small amount in the tungsten ores of the Blue Wing district as waxy to ocherous fillings in small cavities in rusty quartz which contains hubnerite. This material is found, upon microscopic examination, to be very finely crystalline with an index of refraction much above 1.84, which proves that it is tungstite rather than ferritungstite, which, while similar in appearance has an index of refraction of 1.80 and below.

CERVANTITE

Antimony oxide, $Sb_2O_3.Sb_2O_5$. Orthorhombic.

Cervantite or antimony ocher is the name usually applied to yellow pulverulent materials occurring as oxidation products of stibnite. Such bright yellow ocherous materials have been called cervantite, although no definite confirmation of the identification has been obtained. The status of cervantite as a species is somewhat in doubt.

BLAINE COUNTY

Cervantite is reported to have been mined on Wood River.[90]

SHOSHONE COUNTY

Both at the Stanley mine in George Gulch above Burke and at the Coeur d'Alene antimony mine of Pine Creek and probably at other antimony mines in the county, the stibnite of the ore is often slightly altered with the formation of thin coatings of a bright yellow ocherous material which has been called antimony ocher or cervantite. This is always in very thin crusts, apparently passing over into the dirty whitish hydrated oxides mentioned under stibiconite.[91]

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[90] E. S. Dana. System of Mineralogy, sixth edition, p. 1092, 1895.

[91] Earl V. Shannon. Amer. Mineralogist, vol. 3, p. 24, 1918.

STIBICONITE (222)

Hydrated antimony oxide, $Sb_2O_4.H_2O$. Amorphous.

Stibiconite, like cervantite, is a species of poorly established composition and is exceedingly variable, especially in water content. It probably includes several distinct minerals. All of the white to grayish and brown alteration products of stibnite are at present designated stibiconite, although no detailed work has been done on the Idaho materials.

SHOSHONE COUNTY

At the Stanley antimony mine above Burke lumps of stibnite are often coated with crusts from 1 to 5 cm. thick, of dirty white alteration products. Nearest the stibnite these contain a layer, usually less than 1 cm. in thickness, of compact material of opaline appearance and pale brown color and waxy luster. This grades outward into chalky white material containing much more water than required for the stibiconite formula. In small cavities in quartz from the uppermost tunnel of the Stanley mine there occur thin coatings of a yellow, brownish yellow, or green material which is soluble in hydrochloric acid. The solution reacts for antimony and iron.

Specimens from the antimony mine near Glidden Pass are fibrous or bladed pseudomorphs of dirty white oxidation products after stibnite.

Much of the vein material along the outcrop and in surface workings of the Coeur d'Alene antimony vein on Pine Creek consists of a breccia of bleached and altered slate fragments cemented by earthy or chalky white, grayish, or brown hydrated antimony oxides referable to stibiconite.

CUPRITE (224)

Cuprous oxide, Cu_2O. Isometric.

Cuprite, or red copper ore, is known from a number of copper-bearing veins in Idaho, where it has formed from the oxidation of primary copper-bearing sulphides. The following localities have been noted.

CUSTER COUNTY

In the Alder Creek (Mackay) district specimens of ore from the 300-foot level of the Alberta mine contain nodular bunches of cuprite embedded in chrysocolla. The nodules, which are an inch or less across, invariably are surrounded by a layer of tenorite about an eighth of an inch thick.[92]

Specimens from the Mackay district contain some deep red crystals resting on limonite crusts on garnet rock containing disseminated chalcopyrite. These were suited for measurement on the goniometer and were combinations of the cube, *c*(010) predominating, with modifying faces of the octahedron *p*(111) and the rhombic dodecahedron *d*(110), as shown in Figure 32. The isometric symmetry is established by the following measurements:

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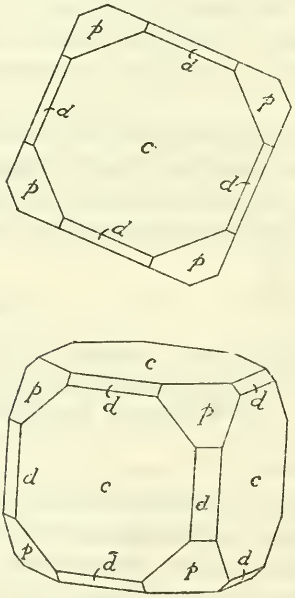
[92] J. B. Umpleby. U. S. Geol. Survey, Prof. Paper 97, p. 52, 1917.

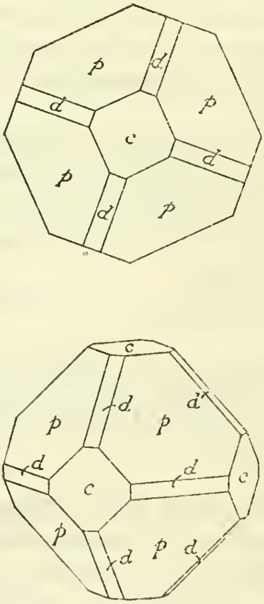
Angles of cuprite from Custer County

Form		Symbol		Quality, description	Measured		Calculated	
No.	Letter	Gdt.	Miller		φ	ρ	φ	ρ
					° ′	° ′	° ′	° ′
1	*c*	0	001	Very good		0 00		0 00
2		0∞	010	do	0 00	90 00	0 00	90 00
3	*d*	∞	110	Medium	44 56	90 00	45 00	90 00
4	*p*	1	111	do	45 09	54 42	45 00	54 44

In addition to the small symmetrical crystals there occur, on the same specimens, elongated crystals grading toward the capillary form of cuprite called chalcotrichite. These form reticulated meshes in which the angle of intersection is 90 degrees.



32



33

Figs. 32–33.—32, Cuprite. Dominantly cubic crystal modified by octahedron and dodecahedron. Mackay, Custer County. 33, Cuprite. Dominantly octahedral crystal modified by dodecahedron and cube. Caledonia Mine, Shoshone County

Specimens from the Skylark mine, Bay Horse district, contain small deep red cuprite crystals coating cracks in rusty iron-stained rock. These are an oxidation product of tetrahedrite. The crystals are octahedral in form but the larger exhibit small faces of the cube and rhombic dodecahedron. Some of them are moderately elongated.

LATAH COUNTY

Cuprite occurs in the shallow oxidized zone of the Mizpah deposit, Hoodoo district, associated with malachite, azurite, chrysocolla, etc.[92a]

LEMHI COUNTY

Cuprite occurs in oxidized ore from the Indian Claim, Blackbird district, as grains in quartz. These show good cleavage and are surrounded by malachite and chrysocolla. Fine grained and massive forms are also found in a few parts of the Copper Queen and Copper King mines, and in the Patterson district.[93]

SHOSHONE COUNTY

Much of the oxidized ore formerly mined in the Snowstorm mine near Larsen, above Mullan, Coeur d'Alene district, contained cuprite with malachite and iron oxides.

Cuprite was common in the rich silver-copper ores of the upper levels of the Caledonia mine worked through the old shaft west of Wardner. The cuprite was the first product of the decomposition of tetrahedrite. Where tetrahedrite was oxidizing in a matrix of porous quartzite, beautiful specimens were commonly found showing residual cores of tetrahedrite surrounded by concentric rings of cuprite, azurite, malachite, and chrysocolla. Porous masses resembling coke were common in parts of the ore. These were brilliant gray with sparkling metallic luster, gave high returns in silver, and had a red streak. For these reasons they were commonly called ruby silver ore, but all of those examined were cellular tetrahedrite mixed with minute and brilliant crystals of cuprite. No reliable specimen of ruby silver has been seen from this mine. Massive granular and spongy cuprite also occurred in the ore, and cavities in the cuprite masses often contained minute grains and filiform wires of native copper. Distorted and much flattened crystals of cuprite were found in cracks. These are chiefly octahedral in form and reach a maximum of about one-fourth of an inch in diameter. They are deep red and transparent with submetallic luster. Numerous specimens of rusty limonite-stained quartzite found on the 500-foot level about 1915 are spangled with minute transparent deep red cuprite crystals associated with cerusite crystals on a velvety layer of limonite. These are very perfect, the predominating form being the octahedron, with or without small modifying faces of the cube and dodecahedron, the form being as illustrated in Figure 33. The following measurements, which were made on a crystal taken from a specimen in the collection of Col. W. A. Roebling, establish the identification and isometric symmetry of the mineral.

[92a] D. C. Livingston and F. B. Laney. Idaho Bur. Geol. and Mines, Bull. 1, p. 95, 1920.

[93] J. B. Umpleby. U. S. Geol. Survey, Bull. 528, p. 76, 1913.

Measurements on cuprite from Caledonia mine

Form		Symbol		Quality, description	Measured		Calculated	
No.	Letter	Gdt.	Miller		φ	ρ	φ	ρ
					° ′	° ′	° ′	° ′
1	*c*	0	001	Good	--------	0 00	--------	0 00
2		0∞	010	Medium	0 00	90 00	0 00	90 00
3	*d*	01	011	Poor	0 49	44 56	0 00	45 00
4		∞	110	Poor, narrow	44 46	90 00	45 00	90 00
5	*p*	1	111	Excellent	44 59	54 38	45 00	54 44

Cuprite in earthy and massive form, has also been reported from the Monitor mine and probably occurs in other oxidized copper bearing ores in the copper belt east and south of Mullan.

WASHINGTON AND ADAMS COUNTIES

In the Seven Devils district cuprite is sparingly present in the oxidized copper ores of the contact metamorphic deposits. It is fairly abundant in the Blue Jacket mine,[94] and while not abundant is not unusual in the Peacock mine.[95]

Cuprite has been reported to occur in a silver-bearing ore at the River Queen deposit, one-half mile above Ballards. A specimen in the National Museum labeled as from Little Bar on Snake River contains masses of granular cuprite up to 5 cm. in diameter, containing cavities filled with capillary chalcotrichite. The associated minerals are chrysocolla and brown impure copper silicate.

TENORITE (230)

MELACONITE

Cupric oxide, CuO. Amorphous-monoclinic (?)

To what extent the black copper oxide occurs in Idaho is not known. The mineral has frequently been mentioned as occurring in oxidized copper ores of the State, but many of these may have been misidentified, the material, in some cases at least, being black copper silicate as further discussed under "melanochalcite." The principal localities thus far reported are as follows:

CUSTER COUNTY

Bright black layers which envelop nodular masses of cuprite from the 300-foot level of the Empire mine in the Alder Creek district (Mackay) are probably tenorite. The material has malachite and chrysocolla mixed with it and is in such small amounts that a careful chemical examination was not attempted.[96]

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[94] D. C. Livingston and F. B. Laney. Bull. Idaho Bur. Mines and Geol., No. 1, p. 73, 1920.

[95] Idem, p. 82.

LEMHI COUNTY

Some melaconite is reported to occur in the oxidized ore of the Copper King mine, Eureka district.

SHOSHONE COUNTY

Earthy to compact and waxy-lustered black material which was common in the oxidized ores of the upper levels of the Caledonia mine may have been all or in part melaconite.

WASHINGTON AND ADAMS COUNTIES

Melaconite has often been reported from the various copper mines of the Seven Devils district. Livingston and Laney[97] state that it is third in order of importance in the oxidized ores, although they place a question mark after the identification of the mineral. Numerous specimens from this district preserved in the National Museum labeled melaconite, contain a dense waxy black opaque material. A small sample of this material upon analysis proved to be an impure hydrated copper silicate. The analysis is given under "melanochalcite."

CORUNDUM (231)

Aluminium oxide, Al_2O_3. Hexagonal, rhombohedral.

Corundum has been reported from a number of localities in Idaho, always in loose gravel mined for gold. The mineral has in no instance been found in its original matrix.

BOISE COUNTY

Corundum has been reported to occur in heavy concentrates from gold placers on Gold Fork and other tributaries to Payette River.

CLEARWATER COUNTY

Various shades of blue and green sapphire have been reported to occur in gravel deposits near Pierce in Clearwater County, especially along Rhodes and Oro Fino Creeks. A large lot of the material picked from a placer concentrate from near Pierce (Cat. No. 87504 U.S.N.M.), consists of pebbles and rough worn crystals up to 2 cm. in greatest diameter. These vary greatly in color, ranging from deep blue through pale blue to greenish, chatoyant blue and opaque gray. Some have a sapphire blue core in a grayish to greenish shell. A few are pale grayish pink. Gray dull material greatly predominates. None of the material approaches gem quality. The crystals are rough, imperfect, and worn. Usually they are simple hexagonal prisms terminated by a basal pinacoid, but some are double hexagonal pyramids. Some of them are coated with a white pearly mica which proved, upon microscopic examination, to be muscovite, and in the side of one corundum crystal a crystal of black tourmaline is embedded.

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[96] J. B. Umpleby. U. S. Geol. Surv., Prof. Paper, 97, pp. 54–55, 1917.

[97] D. C. Livingston and F. B. Laney. Idaho Bur. Mines and Geol., Bull. 1, p. 67, 1920.

CUSTER COUNTY

Corundum is reported to occur in gold placers in Stanley Basin in Custer County.

IDAHO COUNTY

Corundum is found near Resort in Idaho County in gold placers. Three crystals from this locality have been examined. The first of these is a large opaque tapering hexagonal pyramid 2.5 cm. in diameter, the second a small hexagonal prism 1 cm. long by 8 mm. thick of pinkish gray color and the third a hexagonal table 1.5 cm. across having a fine bronze color and chatoyant luster.

WASHINGTON COUNTY

Corundum is found in concentrates from the Rock Flat gold placer near Meadows The corundum is abundant associated with numerous garnets. In color the gray to amethyst shades predominate, although pink crystals yielding cut stones up to 1 carat occur and cornflower blue stones of from one-half to 1 carat could be cut from some. A few rubies of poor quality have been found. Much of the corundum has a silky sheen or is opalescent and would yield star sapphire or cat's-eye. Many of the crystals are fine bronze and the larger crystals often have blue ends.[98] The value of the gems sold in 1906 from here is estimated at $300, the most valuable single stone being a pink gem of 1½ carats, valued at $20.[99]

HEMATITE (232)

RED IRON OXIDE

Iron sesquioxide, Fe_2O_3. Rhombohedral.

ADAMS COUNTY

In the Seven Devils district the specularite variety of hematite is abundant in the contact copper ores. It is found as thick curved scales scattered through massive bornite, and in some specimens as thin plates parallel to the faces of garnet or epidote crystals.[1] The mineral is abundant in massive epidote, especially in the more quartzose portions of the veins. In specimens from the Copper Boy dump, specularite forms broad, lustrous plates, and sheaves in epidote. In the ore from the Peacock mine, large, curved hematite plates are associated with bornite and large brown garnets in quartz. Livingston and Laney[2] write that the specular hematite is most abundant in the Lockwood mine.

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[98] Robert N. Bell. Mining Industry of Idaho. Rept. State Mine Inspector for 1906, p. 171. Boise.

[99] U. S. Geol. Survey. Mineral Resources for 1906, p. 1230.

[1] C. Palache. Amer. Jour. Sci., vol. 8, p. 302, 1899.

BANNOCK COUNTY

Minute and very thin hexagonal tabular crystals of hematite occur in NW. ¼ sec. 9, T. 6 S., R. 43 E., on Lanes Creek, inassociation with calcite and quartz crystals in vugs in garnet rock. These show only a basal pinacoid and very flat hexagonal pyramid. The angles measured on the pyramid average $\rho = 7° \ 31'$. This would indicate the rhombohedron (1.1.2.12) calculated ρ for which is 7° 28′. The development of the crystals is shown in the drawing, Figure 34.

BEAR LAKE COUNTY

Bedded red oolitic hematite occurs in an iron prospect 1½ miles southwest of Bloomington in NW. ¼, SW. ¼ sec. 34, T. 14 S., R. 43 E.

BOISE COUNTY

Large pebbles of granular hematite are found in the Leary and Brogan placers.

CUSTER COUNTY

In the copper deposits of the Alder Creek district both the red, earthy, secondary form of hematite and the specularite variety are abundant. The former, in deep red ocherous masses, greatly exceeds limonite in amount. Specularite occurs abundantly, usually intergrown with magnetite. Elsewhere in the county earthy hematite is widespread as an oxidation product.

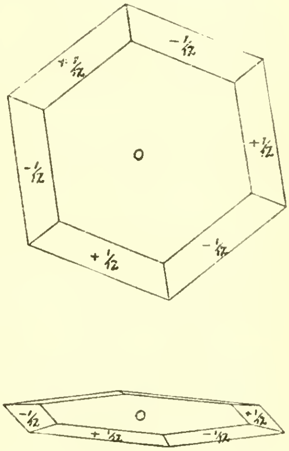

Fig. 34.—Hematite. Very thin tabular crystal from Bannock County

LEMHI COUNTY

In the Allie vein, 50 feet up from the Allie crosscut, reddish micaceous specular hematite occurred with ocherous limonite. Specular hematite is reported by H. T. Stearns as abundant with quartz and a little copper carbonate in a vein 5 feet wide on Spring Mountain in the Spring Mountain district.

SHOSHONE COUNTY

In the Coeur d'Alene district ocherous red hematite is found in a few places as an oxidation product in the weathered portions of ore deposits, but is greatly subordinate in amount to limonite. It has been noted in the surface ores of the Mammoth and Bunker Hill mines, and soft, friable masses of micaceous scales have been seen in oxidized material on the dumps of the upper Sullivan tunnel of the latter. In a short tunnel on the east fork of Milo Creek above Wardner, a short distance above the forks, hematite in soft ocherous and compact red form is abundant. Much of the material in the upper tunnel of the Lombardy claim in Italian Gulch north of Kellogg is earthy red hematite.

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[2] Idaho Bur. Mines and Geol., Bull. 1, p. 76, 1920.

The specularite variety of hematite which has metallic luster and gray to black color is often mistaken for galena. This variety is common in the Coeur d'Alene district. A large mass occurs in quartz on a tributary of the west fork of Big Creek east of Kellogg Peak; specimens showing curved plates of specularite embedded in limonite are found in the Yankee Girl Mine on Big Creek, and in the Yankee Boy mine the mineral is present in narrow barren veins with quartz, calcite, and siderite. Bunches of finely micaceous scales of deep red specularite resembling graphite were found in the oxidized ore of the Sullivan mine. This mineral has also been found in small seams in and near the monzonite mass near Gem and on Ninemile; in the Shuck Bros. claims near Jackass Peak, north of Kellogg; in the Guelph workings near Sunset Peak; and on G. M. Burt's claims on Placer Creek, south of Wallace. Compact-fibrous botryoidal and stalactitic hematite occurs in some veins on the west fork of Pine Creek, often in concentric layers alternating with limonite or goethite.

WASHINGTON COUNTY

In the vicinity of Iron Mountain, 6 miles east of Mineral, great bodies of hematite are found, the principal deposit being a great talus stream composed of blocks up to 20 tons in weight, extending down a steep slope for 1,000 feet. At the top of the slope there are exposed lenses of crystalline hematite 25 feet wide and 100 feet long, in a siliceous porphyry intrusion 100 feet wide which contains 25 per cent iron in the form of disseminated hematite. Other smaller lenses occur. Shallow development on some of the lenses seems to indicate that they pass at slight depth into bodies of pyrite.[3] Others are clearly of contact origin and lie between granite and garnet rock. One of the latter is 50 to 100 feet wide and extends down the north side of Iron Mountain for 1,000 feet.[4] The hematite contains small amounts of copper and gold. At the Barton mine in the same general region one lens of pure hematite is 50 feet wide and 150 feet long.

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[3] Robert N. Bell. 20th Rept. Min. Ind. Idaho, p. 108, 1918.

[4] J. B. Umpleby. U. S. Geol. Survey, Notebook for season 1915.

ILMENITE (233)

MENACCANITE, TITANIC IRON

Ferric titanate, $Fe_2O_3.Ti_2O_3$, variable. Rhombohedral, tetartohedral.

Ilmenite has been noted in Idaho chiefly as a constituent of the black sand residues from gravel washings, especially in the Snake River sands and in the Idaho Basin. It is abundant in the heavy sands, probably being present in excess of magnetite in all of those examined except in one from Bear Creek, in Camas County. In part the mineral occurs in irregular grains, and can not easily be distinguished from similar grains of numerous other opaque black minerals. The majority of the ilmenite is in more or less distinct tabular crystals which are hexagonal-trigonal in form. In the monazite-bearing sands of the Boise Basin and the Clearwater region ilmenite is present in amount greatly in excess of magnetite. Here this mineral occurs in fine to coarse grains, which are, for the most part, distinctly tabular in form with three or six sided bright basal pinacoids present, although the edges are dull or etched and rarely show good crystal faces. Often the basal pinacoid shows triangular markings which are very characteristic. A typical crystal is shown in the orthogonal and perspective drawings of Figure 35. The angles measured on crystals similar to this are given in the present author's paper on the black sands of Idaho.[5]

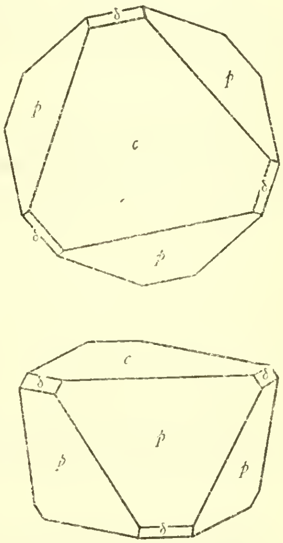

Fig. 35.—Ilmenite. Typical crystal from black sand from Boise County

The ilmenite of the monazite sands, which is in all probability derived, as are the associated monazite and zircon, from the granitic rock of the Central Idaho batholith, is not attracted to a magnet. In the fine sands of the Snake River about one-half of the total amount of black iron ore is extracted by a magnet, both the nonmagnetic and the magnetic portions being composed of irregular black grains and disseminated brilliant thin tabular crystals of ilmenite. Only rarely does a magnetic grain show the typical octahedral form of magnetite, and it may be that the black mineral is practically all ilmenite. The ilmenite of Snake River sands thus is in considerable part magnetic as contrasted with the nonmagnetic character of the same mineral in the sands of the granite regions.

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[5] E. V. Shannon, Mineralogy of some black sands from Idaho, with a description of the methods used for their study. Proc. U. S. Nat. Mus., vol. 60, art. 3. pp 1-33 921

The source of this mineral in these fine sands of the Snake River is not certain. It is noteworthy, however, that the thin sections of the diabasic rock, which occurred abundantly in sand from Minidoka, contained numerous scattered tabular crystals of ilmenite.

SPINEL (234)

Magnesium-iron aluminate, $(Mg,Fe)O.Al_2O_3$. Isometric.

Spinel has been mentioned as occurring at a few places in Idaho but nowhere in large crystals.

ADAMS COUNTY

Spinel is listed, without description, by Livingston and Laney[6] as occurring in the contact copper deposits of the Seven Devils district.

CUSTER COUNTY

Small grains of spinel occurring with chondrodite in a chondrodite limestone from the head of Wildhorse Canyon in the Hailey quadrangle have been described under chondrodite.

MAGNETITE (237)

MAGNETIC IRON

Ferrous-ferric oxide, $FeO.Fe_2O_3$. Isometric.

BLAINE COUNTY

Magnetite occurs in small amount in the Wood River district as a contact mineral in limestone.

CUSTER COUNTY

Magnetite, as is to be expected, is abundant in the vicinity of the contact-metamorphic copper deposits of the Alder Creek district. It is abundantly developed in the Iron and Quarry tunnels and is found locally throughout the deposits. It is characteristically fine-grained and associated with specularite or an equal amount of garnet. It is not plentiful in association with chalcopyrite. On the ridge northwest of the Copper Bullion tunnel it occurs as veinlets of coarse crystals cutting garnet rock. Here the garnet contains cores of magnetite. Common assays of the magnetite rock show 50 per cent iron, 1 per cent of copper, 0.002 ounce gold, and 0.57 ounce of silver a ton.[7]

LEMHI COUNTY

Magnetite in moderate amounts is widespread in occurrence. In the Carmen Creek district it is found in the ores included in the vein quartz where the adjacent wall rock contains actinolite and epidote; in the Eureka district it is present in some of the veins; in the Mineral Hill district it appears with the ores, especially in the Pine Creek deposits; and in the Spring Mountain district, it is developed in large quantities in the low-grade copper deposits of the Bruce estate, where it occurs as a contact mineral in limestone adjacent to an intrusion of quartz-diorite.[8] The magnetite is mixed with bornite and ludwigite.

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[6] Idaho Bur. Mines and Geol., Bull. 1, p. 62, 1920.

[7] J. B. Umpleby. U. S. Geol. Survey, Prof. Paper 97, pp. 53–54, 1917.

SHOSHONE COUNTY

Magnetite is common in the Success mine on Ninemile Creek in fine granular masses mixed with sphalerite and pyrite. It is extracted in chunks from the ore with large magnets before milling. It may also be present in considerable amounts in the ores of the Helena-Frisco and Rex (Sixteen-to-one) mines, which resemble those of the Success mine. In the Greenhill-Cleveland and Standard-Mammoth ore bodies magnetite was abundant in the lower levels where it was intergrown with pyrite and siderite. The magnetite seemed in some cases to have resulted from alteration of siderite and sometimes occurred in masses preserving the granular structure and imperfect rhombohedral cleavage of the siderite. The ore minerals galena and sphalerite are not contemporaneous with this magnetite-bearing aggregate but are present in later seams. It appears that here a normal siderite-galena ore was deposited and later increases in temperature, and changes in conditions caused the removal of the ore minerals to a higher level with coincident reduction of siderite to magnetite and deposition of large quantities of pyrrhotite. At a later period this base aggregate was shattered and the fractures filled with ore minerals, including galena, tetrahedrite, jamesonite, boulangerite, chalcopyrite, and even pyrargyrite (q.v.). Magnetite has been noted in considerable masses in quartz from the outcrops of the Palisade mine, Pine Creek district.

WASHINGTON AND ADAMS COUNTIES

Magnetite is found in the Blue Mountain gold belt, Mineral district.

MINIUM (244)

RED LEAD

Lead oxide, $2PbO.PbO_2$ Pulverulent.

BLAINE COUNTY

The rare mineral minium has been found in ores of the Wood River district, especially at the Jay Gould mine, where it coated native lead or occurred as an impregnation in quartz containing native lead.[8a]

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[8] J. B. Umpleby. U. S. Geol. Survey, Bull. 528, p. 77, 1913.

[8a] William P. Blake. Amer. Journ. Sci., vol. 25, p. 161, 1883. W. F. Hillebrand, U. S. Geol. Survey, Bull. 20, p. 99, 1885. E. S. Dana, System of Mineralogy, p. 231, 1895. Waldemar Lindgren, 20th Ann. Rept. U. S. Geol. Survey, pt. 3, p. 189.

It was found by D. F. Hewett with cerusite in oxidized ore of the Plughof (formerly the Lark) mine, 2 miles southwest of Bellevue.

CUSTER COUNTY

Minium has been noted in small amount in specimens from the upper portion of the Beardsley vein, Bay Horse district.[9]

LEMHI COUNTY

Minium occurs as a bright red powder of greasy luster partly filling little cavities in the oxidized ore near the surface in the Pittsburg-Idaho mine in the Texas Creek district,[10] and in fine specimens associated with plattnerite and siderite in the Democrat claim of Frank Grooms, near Gilmore.

OWYHEE COUNTY

Minium has been found in oxidized lead ores from the South Mountain district.

SHOSHONE COUNTY

The only reported occurrence of this mineral is on the Silver Dollar claim in Idaho Gulch, 2 miles east of Murray, where it occurs with galena.[11]

BRAUNITE (247)

Manganese oxide-silicate, $3Mn_2O_3.MnO.SiO_2$. Tetragonal.

LEMHI COUNTY

This oxide of manganese is reported by Umpleby to occur in the ores of the Kittie Burton mine, Indian Creek district, Lemhi County, as small brownish-black granular masses and scattered minute pyramidal crystals.[11a] This is a gold-bearing vein of bluish coarse vein quartz containing abundant pyrite with braunite, chalcopyrite, and pyrrhotite. Small amounts of rhodochrosite coat fractures in the ore.

CASSITERITE (248)

Tin dioxide, SnO_2. Tetragonal.

LEMHI COUNTY

Stream tin occurs along Panther Creek near its junction with Moyer Creek and is also reported from Silver Creek. In neither place, however, have deposits of commercial extent been demonstrated.[11b] The latter deposit has been prospected sufficiently to show the absence of tin in commercial quantity, but the former is inadequately developed. Individual pieces of the cassiterite vary in size from small rounded grains to pebbles a half inch or more in diameter. The tin pebbles as they occur on Panther Creek are sparsely distributed through the lower portion of a bed of gravels which varies from 4 to 20 feet in thickness.

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[9] J. B. Umpleby. U. S. Geol. Survey, Bull. 539, p. 53, 1913.

[10] J. B. Umpleby. U. S. Geol. Survey, Bull. 528, p. 78, 1913.

[11] Adam Aulbach. Correspondence in Wallace, Idaho, Press-Times, about 1917.

[11a] J. B. Umpleby. Bull. U. S. Geol. Survey, No. 528, p. 75, 1913.

[11b] J. B. Umpleby. U. S. Geol. Survey, Bull. 528, pp. 74, 76, 1913.

A specimen (Cat. No. 86,809, U.S.N.M.) in the National Museum is labeled: "Stream wood tin from Prairie Basin, Lemhi County." It consists of waterworn pebbles up to 1.5 cm. in size, of wood tin having the usual radiate fibrous structure and varying colors from pale brown to dark brown, red brown, and black.

OWYHEE COUNTY

Cassiterite has been found in the Silver City district in placers. It is the variety known as wood tin and occurs in beautifully rounded masses from one-eighth to one-half inch in diameter. It was especially noted along Jordan Creek.[11c]

SHOSHONE COUNTY

Stream tin is reported to occur in the Coeur d'Alene district.[11d]

RUTILE (250)

Titanium dioxide, TiO_2 (or titanyl titanate, $TiO.Ti_2O_3$).
Tetragonal.

BOISE COUNTY

Rutile has been noted sparingly in black sands from a number of gold placers in Idaho. A steely lustered prismatic crystal 6 mm. long, found in the polycrase-bearing sand from Centerville, was identified as rutile. The prismatic zone is deeply striated, the forms present being $a(100)$, $m(110)$, and $l(130)$. The crystal is terminated by the pyramid $e(011)$. This crystal is shown in the drawing (fig. 36). It was peculiar in showing greenish internal reflections and when crushed and examined in transmitted light the color was yellowish green, a very unusual color for rutile. As emphasized under "zircon," some of the light colored crystals which have been described as that mineral may be rutile, the angles of rutile and zircon being so similar that very accurate measurements are necessary to distinguish between them.

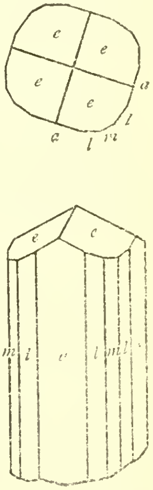

FIG. 36.—RUTILE. CRYSTAL FROM COARSE PLACER CONCENTRATE. CENTERVILLE, BOISE COUNTY

[11c] Browne and Taylor. W. P. Blake, Mineral Resources of United States, 1866, p. 201.

[11d] U. S. Geol. Survey, Bull. 624, p. 115, 1917.

CLEARWATER COUNTY

A sample of coarse concentrates separation product (Cat. No. 87,506, U.S.N.M.) from gravels at Pierce consists very largely of rutile in red-black waterworn pebbles and fragments of crystals up to ¾ inch in diameter. These are mostly red-black in color but some are brown, yellow, or greenish in small fragments under the microscope. Associated with the rutile are tourmaline, corundum, epidote, ilmenite, and some rarer minerals.

SHOSHONE COUNTY

A single small specimen found as float by Mr. Oscar H. Hershey in 1920 on the Lookout Mountain claim, east of the forks of Pine Creek, contains small reddish to steel gray needles of rutile in a narrow quartz seam cutting rusty spotted quartzite from the middle member of the Prichard formation.

PLATTNERITE (251)

Lead dioxide, PbO_2. Tetragonal.

Previous to its discovery in the Coeur d'Alene district, plattnerite was known as two or three specimens from European localities, and its composition, crystallization, and, in fact, its validity as a species were imperfectly established.

LEMHI COUNTY

In the Democrat mine of Frank Grooms in the Gilmore district, plattnerite in massive form was found embedded in specimens of fine red minimum.[12]

SHOSHONE COUNTY

In 1888, Waldo Clark, of Mullan, Idaho, transmitted to the Smithsonian Institution some specimens which were found upon examination to be plattnerite. A considerable amount of this material was secured, and subsequent study placed the mineral as a distinct species of tetragonal crystallization.[13]

The plattnerite came from the You Like lode, now a part of the Morning mine at Mullan, in the Coeur d'Alene district. It was found in the vein in the uppermost tunnel, 70 feet below the surface, as rounded nodules touching each other in a continuous line for a distance of 20 feet, when it gave out for 10 feet in a space occupied by limonite, beyond which there was considerable more plattnerite for 10 to 15 feet, when it disappeared and no more was found in the 40 feet the tunnel continued. It was associated with limonite in botryoidal masses (pl. 13) and as brown ocher. The only other associated mineral was a white pyromorphite in crystals, rarely in veins, scattered through the botryoidal nodules of plattnerite,

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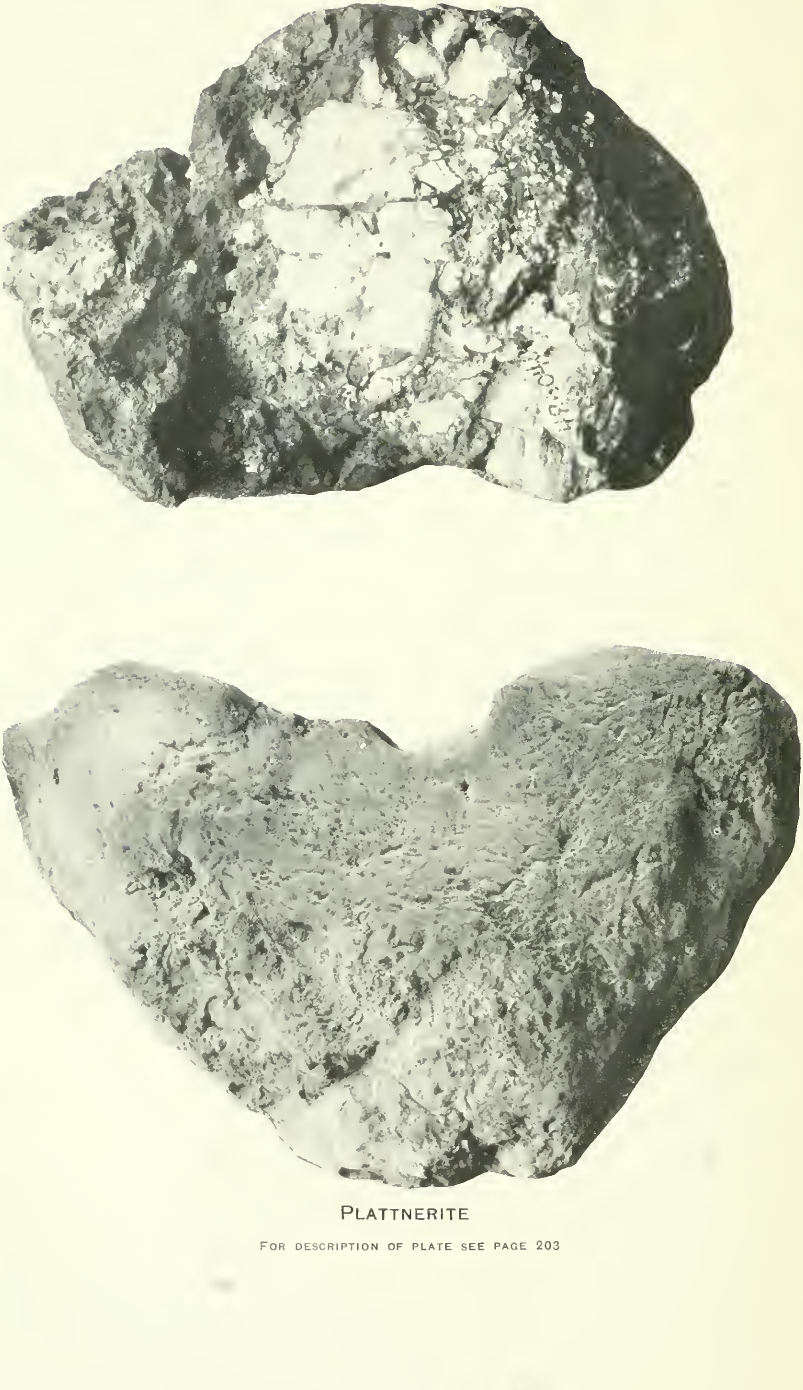
[12] E. V. Shannon. Amer. Mineralogist, vol. 2, pp. 15–17, 1912.

[13] W. S. Yeates and W. Ayres. Amer. Journ. Sci., vol. 43, p. 407, 1892.



PLATTNERITE

FOR DESCRIPTION OF PLATE SEE PAGE 203

which were embedded in a mixed ocher of limonite and plattnerite also containing scattering crystals of pyromorphite. A freshly broken surface of the compact nodules shows a small conchoidal fracture and a metallic-adamantine luster which tarnishes and becomes dull on exposure to the atmosphere for a few weeks. The outside of the nodules is reddish brown (pl. 5, lower), while the interior on fresh fracture is iron black with a compact cryptocrystalline structure. The streak is chestnut-brown; hardness 5.5; specific gravity 8.56. Before the blowpipe on charcoal in the oxidizing flame it decrepitates and fuses at 1 with boiling and spurting, yielding a globule of lead, which, on further heating coats the coal yellow. It is easily soluble in dilute hydrochloric acid, giving off chlorine. An analysis by Yeates of a pure fragment yielded the following results:

Plattnerite, You Like lode

	Per cent.
Lead	83. 20
Silver	Trace.
Copper	. 14
Iron (½ aluminum)	1. 20
Oxygen	13. 93
Insoluble	. 82
Total	99. 29

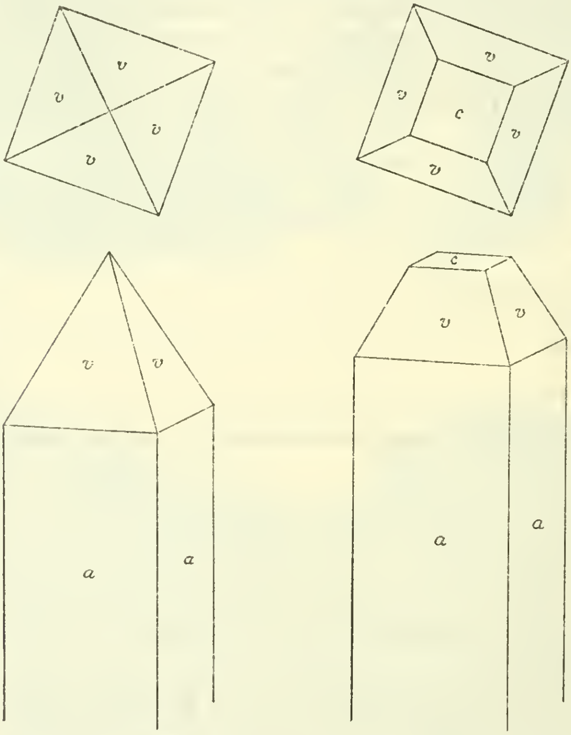
Deducting impurities and recalculating to 100 per cent, this gives:

	Per cent.
Lead	86. 55
Oxygen	13. 45
Total	100. 00

Calcium and magnesium were present in appreciable amounts but were not estimated.

The individual nodules range from 2 by 1 by ½ to 8 by 6¼ by 4¼ inches, one of the largest of the original lot weighing 15 pounds, 4 ounces. Implanted upon many of them are the crystals of pyromorphite, which also speckle the interor. Some of these are brown from thin coatings of plattnerite and look like crystals of that mineral. Sometimes the plattnerite forms a cement binding together brecciated fragments of vein quartz (pl. 5, upper). Some of the nodules were found to be distinctly fibrous in part, fibers running from dense cryptocrystalline material to small open cavities filled with bright yellow ocher and terminating in minute jet black crystals projecting into the ocher. These were too imperfect for the form to be made out. Drusy sides of small fissures in some nodules were found to contain measurable crystals. These were opaque, slender, and from one-fiftieth to one one-thousandth of an inch long. They were found to be tetragonal, isomorphous with and closely resembling cassiterite crystals. The basal plane is very common, and the prevailing forms are like Figures 37 and 38. Many of the smaller crystals have merely the steep pyramid $v(301)$ as in Figure 37. The best crystal is one one-hundred-and-fiftieth of an inch long with the form and proportions shown in Figure 39. The forms noted are as follows:

$a(100)$
$c(001)$
$c(101)$
$v(301)$
$x(332)$



37

38

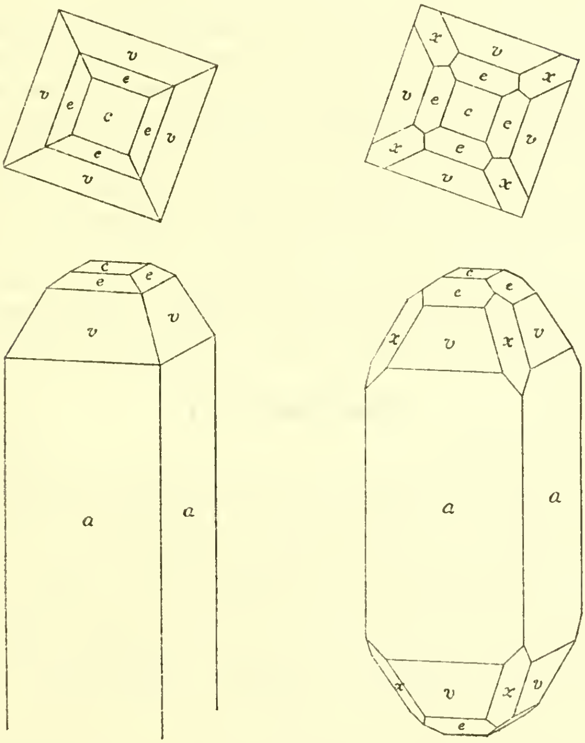
Figs. 37–38.—Plattnerite crystals. You Like Lode, Shoshone County. After Yeates and Ayres

The form $x(332)$ is of rare occurrence, beveling the edge of $v(301)$. The prism faces are rounded and deeply striated. $v(301)$ is unusually bright, large, and well defined. The angle $(301) \wedge (\bar{3}01)$ was taken as the fundamental angle; the mean of many measurements gave 127° 32′. This angle gives:

$$a:c = 1:0.67643$$

The angles observed by Ayres are as follows:

	Calculated			Measured		
	°	′	″	°	′	″
$301 \wedge \bar{3}01$	127	32		127	32	
$301 \wedge 100$	26	14		24	30	
$301 \wedge 101$	29	41	28	28	1	
$101 \wedge 100$	55	55	28	54	39	30
$101 \wedge 001$	34	4	32	35	20	30



39 40

FIGS. 39-40.—PLATTNERITE. YOU LIKE LODE, SHOSHONE COUNTY. AFTER YEATES AND AYRES

The optical properties of plattnernite from this lot have been determined by Larsen[14] as clouded and nearly opaque, with no noticeable birefringence, refractive index for lithium light 2.30±0.005.

The locality on the You Like lode is said to have produced masses of the mineral up to 200 pounds in weight.[15]

In the stope above the No. 2 tunnel of the Mammoth mine at Mace, plattnerite is reported to have been found occasionally in the early days as masses up to 100 or more pounds in weight. Lease workings in 1913 yielded small, brownish nodules and botryoidal masses of the mineral on the footwall side of the vein. Beautifully botryoidal masses, with brilliant metallic-adamantine luster occurred formerly in the ores of the Hercules mine at Burke; a compact, massive variety was found on the sorting belt of the Last Chance mine at Wardner in 1915, when much of the ore was coming from above the No. 1 tunnel; and specimens are said to have been found in the Bunker Hill open cut.

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[14] Esper S. Larsen. U. S. Geol. Survey, Bull. 679, p. 121, 1921.

[15] Earl V. Shannon Notes on unusual masses of plattnerite. American Mineralogist, vol. 2, pp. 15-17, 1917.

The oxidized ores of the mines producing plattnerite have been mostly exhausted. In the days when this mineral was found it was believed to be iron and was usually discarded, so that a search of the dumps of tunnels and cuts in the upper portions of these veins should yield a number of good specimens, and lease workings in oxidized ores should be carefully examined for this mineral. Good specimens have not been found elsewhere in America than in the Coeur d'Alene district and the locality in Lemhi County mentioned above, although reported from South Dakota. Localities in Scotland and elsewhere in Europe produced a few specimens many years ago, and its occurrence at Tsumeb, German Southwest Africa has been noted. Specimens from the Mullan locality are now in all good collections throughout the world.

PYROLUSITE (254)

Manganese dioxide, MnO_2 Orthorhombic.

Pyrolusite and psilomelane are the two most common oxides of manganese found in a great variety of situations. The principal recognizable difference between these is that pyrolusite is commonly crystalline in appearance and is lighter in color, while psilomelane is usually black and amorphous. Of the occurrences of manganese oxides noted in Idaho, in the absence of more definite determinations, the ones showing distinctly crystalline structure are referred to pyrolusite and the balance are placed under psilomelane. The identifications of other authors are copied without change, while descriptions of manganese oxide without further detail are placed under psilomelane. Although a number of occurrences are known, none is economically important.

BLAINE COUNTY

Manganese oxide is reported to be abundant in ores of the Scott (Birch Creek) mine in the Birch Creek district.[16]

A specimen of this material is a spongy, drusy mass of pyrolusite.

Specimens sent to the National Museum by Mr. B. A. Smith, of Martin, from his prospect in the Lava Creek district, 20 miles west of Arco, consist of impure pyrolusite. Other specimens from the same locality are wad and tourmaline.

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[16] J. B. Umpleby. U. S. Geol. Survey, Prof. Paper 97, p. 118, 1917.

CUSTER COUNTY

In the copper deposits of the Alder Creek (Mackay) district, pyrolusite occurs as dendrites on fracture surfaces in the limestone, and as black, sooty material mixed with iron oxides in the oxidized ore.[17] In northwestern Custer County, dendritic pyrolusite is not uncommon along fractures in the lead-silver deposits.[18]

LEMHI COUNTY

The pyrolusite found in Lemhi County is worthy of special mention because of its beautiful dendritic forms. These, which resemble frost figures or branching vegetation, are abundant in many places along fractures and bedding planes in limestone adjacent to the lead-silver deposits. Manganese oxide is coextensive with iron oxide. In many places in the lead silver deposits it is very conspicuous.[19]

SHOSHONE COUNTY

Manganese oxide, probably including some pyrolusite, is widespread in occurrence, mixed with iron oxides and cerusite, in the upper portions of the lead-silver veins of the Coeur d'Alene district, as further discussed under psilomelane. A few occurrences of well-characterized pyrolusite have been noted. In a rusty and much brecciated quartz vein encountered by the lower tunnel of the north Bunker Hill at the west side of Milo Creek at the east base of Haystack Peak at Wardner, steel gray crystalline rosettes of pyrolusite were found in 1915–16. On the 800-foot level of the Hercules mine at Burke an open crack along a fissure in quartzite was lined with a crust of crystals of calcite upon which were deposited mossy masses of minute pyrolusite crystals. Fibrous striated blades and masses of pyrolusite, secondary after manganiferous siderite, occur with limonite in quartz from the Black Diamond claims in the Pine Creek district.

GOETHITE (257)

Hydrous iron oxide, $Fe_2O_3.H_2O$. Orthorhombic.

Goethite is a crystalline form of ferric hydroxide having the same composition as limonite, with which it is commonly associated. Limonite is amorphous and usually holds some excess water. This amorphous ferric hydroxide tends to go over to the crystalline form becoming goethite, having a very finely fibrous form and black botryoidal lustrous surfaces. While goethite is known to occur in some localities elsewhere as distinct prismatic crystals, such crystals have not, thus far, been reported from Idaho and the occurrences mentioned below are all of the metacolloidal finely fibrous botryoidal material. The crystalline structure is what identifies the mineral as goethite rather than limonite and this, in most cases, is best determined by observing its double refraction under the microscope.

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[17] J. B. Umpleby. U. S. Geol. Survey, Prof. Paper 97, p. 94.

[18] J. B. Umpleby. U. S. Geol. Survey, Bull. 539, p. 53, 1913.

[19] J. B. Umpleby. U. S. Geol. Survey, Bull. 528, p. 78, 1913.

BLAINE COUNTY

Specimens of iron oxide from the Narrow Gauge shaft are cellular sponges made up of finely fibrous metacolloidal goethite.

CUSTER COUNTY

A lot of material sent in to the National Museum for identification by Mr. J. W. Cooper from Hill City, Custer County, consists of small botryoidal goethite, with a finely fibrous structure, on fractures.

LEMHI COUNTY

Ordinary small-botryoidal radial fibrous dark-brown masses of goethite occur in cavities in quartz in specimens from the Big Chief claim, Blackbird district.

SHOSHONE COUNTY

Botryoidal goethite is probably found near the surface in the oxidized ore of a majority of the Coeur d'Alene mines. It seems especially to occur at or very near the surface and small black coatings are universally present. Fine specimens occur in a prospect in the basin at the head of the east fork of Milo Creek above Wardner and in various shallow openings about the flanks of Snow Patch (locally called Kellogg) Peak, including one prospect tunnel on the southeast side of the shoulder immediately below the summit of the peak. Specimens occur in the outcrop of the Caledonia vein and underground in this mine at shallow depth. Specimens of this mineral have also been examined from the Palisade claim on Pine Creek.

LIMONITE (259)

Hydrated iron oxide, $2Fe_2O_3.3H_2O$. Amorphous

Limonite, the hydrated iron oxide which is probably the amorphous equivalent of goethite, is one of the commonest of minerals formed under the influence of surface weathering. It results from the decomposition and oxidization of iron-bearing minerals, not only the sulphides and carbonates of veins but also from ferrugineous silicates such as hornblende, pyroxenes, chlorites, iron-bearing micas, etc. Common iron rust is limonite and as rust brown stains this mineral is present everywhere. In veins the limonite results from the oxidation of iron-bearing sulphides, as pyrite, pyrrhotite, marcasite, chalcopyrite, arsenopyrite, and bornite; from the alteration of iron-bearing carbonates, as siderite, ankerite, and ferriferous calcite, and from the oxidization and hydration of the oxides, magentite, and hematite. In the oxidized portions of ore bodies limonite occurs as cellular masses of light yellow to dark brown color, sometimes soft and earthy and at other times hard and compact. Only a few localities for such a widespread mineral can be mentioned.

ADAMS COUNTY

In the Seven Devils and other districts of Adams County limonite occurs commonly as typical gossans or "iron-cappings," forming the outcrops of the contact-metamorphic copper deposits and of large low-grade masses of pyritic material.

ADA, BOISE, CLEARWATER, ELMORE, AND IDAHO COUNTIES

In the gold-producing districts of central and southern Idaho limonite occurs commonly in the upper portions of gold veins, filling cavities in quartz originally occupied by auriferous sulphides, chiefly pyrite and arsenopyrite. The original gold content of the sulphide remains in the secondary limonite in the form of native gold. Such gold which has been liberated from its inclosing sulphide by weathering is readily extracted by amalgamation and such oxidized and limonitic ores are the "free milling" ores formerly so important in Idaho. Sometimes the limonite formed by the oxidation of pyrite crystals is a hard and lustrous dark-brown material which has the form of the original crystal of pyrite, thus being a pseudomorph of limonite after pyrite. A specimen from the Lolo Claim, Wieppe district, Clearwater County, contains limonite pseudomorphs after pyrite showing faces of the cube and pentagonal dodecahedron, up to 2 cm. in diameter.

BLAINE COUNTY

In the Wood River district the limonite which was abundant in the surface ores was probably in considerable part derived from siderite. In the Muldoon district large masses of limonite have been mined for use as a flux.

CUSTER COUNTY

In the Alder Creek district limonite occurs in the usual forms, although here earthy hematite is more abundant. In the lead-silver deposits of the county limonite, probably in large part derived from siderite, is abundantly mixed with cerusite. It occurs in the oxidized portions of all veins, its amount dependent only upon the amount of iron supplied by the primary mineralization. In a tributary to Wildhorse Canyon limonite is deposited in large amount as a slimy yellow mud by the water of a mineral spring.

FREMONT COUNTY

In the Skull Canyon district limonite occurs in the Weimer Copper mine as a dense jaspery material containing malachite. In the Kaufman and Weaver mine it forms a soft earthy ocher mixed with lead carbonate.

LEMHI COUNTY

In Lemhi County limonite in the usual forms is abundant in almost every district. Waxy amorphous limonite has been noted in specimens from the Creek tunnel on Patterson Creek. In the Texas district limonite in ocherous form is abundantly mixed with cerusite in the lead ores. A specimen from the Oriole lower tunnel on the north side of Liberty Gulch contains abundant small and perfect pyritohedral pseudomorphs of limonite after pyrite in a gangue of calcite and ocherous limonite. Another specimen from the Copper Queen mine, McDevitt district, likewise shows pyritohedral pseudomorphs of limonite after pyrite.

SHOSHONE COUNTY

Limonite is very common in the oxidized portions of the lead-silver deposits of the Coeur d'Alene mining district. Great craggy masses which mark the outcrops of many veins consist of fragments of quartzite cemented by limonite, and this mineral is abundant in the surface cuts of nearly all mines. It occurred both as hard and compact jaspery material, as soft ocherous masses, and as cellular or spongy dark velvety brown masses in the oxidized ores associated with much cerusite. This limonite has to some extent been derived from pyrite, but its most abundant source has been the siderite which is the principal gangue mineral of the deposits. As the gangue siderite is somewhat manganiferous, much of the limonite is also manganiferous. The Evolution vein near Osburn contains a wide filling of ferrugineous calcite and, where this has oxidized, large amounts of limonite remain behind. Large masses of limonite result from the alteration of ankerite and siderite veins south and east of Mullan.

The mine waters of the Bunker Hill mine contain much iron in solution in the form of the bicarbonate. Where these waters drip into abandoned workings the iron becomes oxidized by contact with the air and is precipitated as a slimy ooze of limonite on the sides and floors or hardens into stalactites of limonite which hang from the roof.

PSILOMELANE (269)

Hydrous manganese oxide, formula doubtful, possibly a hydrated colloidal mixture of MnO and MnO_2.	Amorphous.

Psilomelane is probably the commonest of the manganese oxide minerals, and for this reason all occurrences of black oxide manganese minerals not sufficiently well characterized to be definitely referred to pyrolusite or some other more definite species are mentioned under this name. Numerous minor occurrences are known of which a few typical localities are mentioned.

LEMHI COUNTY

In the Parker Mountain mine, Parker Mountain district, earthy black manganese oxide, probably psilomelane, occurs as a friable powder and also impregnating aragonite giving black rosettes. Specimens from the incline shaft, No. 4 tunnel of the Patterson Creek tungsten mine, Blue Wing district, show dull black plumose-fibrous psilomelane resting on drusy quartz.

SHOSHONE COUNTY

Psilomelane is probably widespread in occurrence in the oxidized lead-silver ores of the Coeur d'Alene district in impure earthy form or mixed in small proportion with limonite. The characteristic gangue mineral in the unoxidized ores of this district is manganiferous siderite, and this, upon oxidation, yields mixed iron and manganese oxides. Much of the limonite is darker brown in color than is common for this mineral, due to the manganese content.

Earthy ocherous manganese oxide was found as a soft streak containing heavy masses of pearly white cerusite in the McBride lease on the Tyler mine in 1912. The best psilomelane thus far found in Idaho came from the 500-foot level of the Caledonia mine where it occurred on the level near the old inclined shaft as a streak of black ocherous material up to 2 feet wide containing coherent botryoidal steel gray to iron-black masses made up of separable concentric shells. Steel-gray impregnations of psilomelane are common in quartzite on the surface at many places in the district, having been particularly noted in the vicinity of the outcrop of the Caledonia vein and at the east foot of Haystack Peak.

During the war demand for manganese a number of prospects were explored in search of manganese ore of commercial grade. Ore from none of these has been examined by the writer, and in the absence of definite mineralogical data they are referred to here, since the manganese mineral is most probably psilomelane. The principal prospects have been mentioned by Livingston.[19a] The Cummings property, 1 mile east of Prichard, has opened a low-grade deposit showing manganese oxide cementing a brecciated quartzite of the Revett formation and the Butte-Detroit claim, 2 miles below Delta, has exposed a similar manganiferous zone 65 feet wide in the same formation. The Ione group, on the top of the ridge between Bear and Paragon Gulches, has found low-grade manganiferous material in the oxidized portion of a lead-bearing vein. The Waring property on Ninemile Creek, 3 miles from Wallace, and the Vienna-International mine, 7 miles from Wallace, on Placer Creek, have prospected for manganese ore in brecciated zones carrying manganese oxide as a cement.

[19a] D. C. Livingston. Univ. of Idaho School of Mines, Bull. 2, pp. 37-39, 1919.

WASHINGTON AND ADAMS COUNTIES

Veins carrying manganese oxides occur along Snake River about 20 miles below Huntington. The ore is low grade and siliceous, with a quartz and jasper gangue. Several claims were actively prospected during the war demand without revealing important bodies of manganese ore.[20]

PSILOMELANE, variety WAD

The material called wad, and commonly regarded as a variety of psilomelane, occurs at one locality in Idaho as rather unusually good material which merited a detailed examination the results of which are here presented.

BLAINE COUNTY

A specimen of wad sent to the National Museum for identification by B. A. Smith, of Martin, is from his property in the Lava Creek mining district 20 miles west of Arco. The material is rather soft and sectile and, although compact and tough, can be marked with the finger nail, which leaves a black lustrous metallic mark. It has a dark-brown color and, from its color, might be supposed to be a slightly manganiferous limonite. It is exceedingly light, large pieces floating for a time on water, although they gradually absorb water and sink. An analysis of this specimen gave the following results:

Analysis of wad from Blaine County

(E. V. Shannon, analyst)

Constituent	Per cent
Insoluble portion and separated silica	5. 80
Ferric oxide (Fe_2O_3)	3. 04
Manganous oxide (MnO)	55. 90
Lime (CaO)	8. 86
Oxygen (O) in excess of MnO	11. 74
Water (H_2O) above 110° C	11. 60
Water (H_2O) below 110° C	4. 10
Total	101. 04

The material is completely amorphous and there is no means of determining whether it represents a homogeneous substance or a mixture of several fine-grained minerals. For this reason no definite formula can be derived from the analysis.

PSILOMELANE, variety ASBOLITE

LEMHI COUNTY

The name asbolite is applied to material usually considered to be wad containing oxide of cobalt. Umpleby states, under asbolite, that earthy cobalt oxide, more or less contaminated with other oxides, occurs in cracks and crevices in the cobalt-nickel ores of the

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[20] D. C. Livingston. Univ. of Idaho, School of Illinois, Bull. 2, pp. 32-34, 1919.

Blackbird district in Lemhi County.[21] A lot of this material from the Togo claim in that district consists in the main of a friable dull black powder, although one fragment of schist shows blue-black crusts along cracks made up of minute globules with dull metallic luster. This black earthy material dissolves readily in hydrochloric acid with evolution of chlorine and in concentrated acid yields a deep blue-green solution which flashes to brownish pink upon dilution. An analysis of this asbolite gave the following results:

Analysis of asbolite from Lemhi County

(E. V. Shannon, analyst)

	Per cent
Insoluble and silica	2. 20
Ferric oxide and alumina (Fe_2O_3, Al_2O_3)	2. 50
Manganese dioxide (MnO_2)	49. 64
Cobalt dioxide (CoO_2)	5. 12
Cobaltous oxide (CoO)	13. 08
Lime (CaO)	6. 10
Magnesia (MgO)	1. 00
Cupric oxide (CuO)	1. 56
Water below 110° C	10. 88
Water above 110° C	8. 24
Total	100. 32

In the above statement the oxygen is calculated first with the MnO until that is used up and the balance is united with the cobalt and stated as CoO_2. Otherwise stated, the results of the analysis are as follows:

	Per cent
Insoluble	2. 20
Manganous oxide (MnO)	40. 50
Copper oxide (CuO)	1. 56
Cobalt oxide (CoO)	17. 30
Lime (CaO)	6. 10
Magnesia (MgO)	1. 00
Oxygen (O) excess	10. 04
Water above 110°	8. 24
Water below 110°	10. 88
Ferric oxide and alumina	2. 50
Total	100. 32

The material is thus a typical asbolite.

DELAFOSSITE (269a)

Copper iron oxide (Cuprous metaferrite), $Cu_2O.Fe_2O_3$. Rhombohedral.

LEMHI COUNTY

A black mineral occurring as streaks in a whitish sandy rock forming copper ore of the Pope Shenon mine in Lemhi County collected by C. P. Ross of the United States Geological Survey has been analyzed and found to be the relatively rare mineral delafossite.[22] This occurrence will be further described by Mr. Ross in a report which is in preparation.

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[21] J. B. Umpleby. U. S. Geol. Survey, Bull. 528, p. 75, 1913.

THE CALCITE GROUP

The calcite group embraces the rhombohedral carbonates of which the simple end members known from Idaho are:

Calcite	Calcium carbonate	$CaCO_3$
Siderite	Iron carbonate	$FeCO_3$
Rhodochrosite	Manganese carbonate	$MnCO_3$
Smithsonite	Zinc carbonate	$ZnCO_3$

In addition to these simple carbonates there are some double carbonates recognized, the most important being:

Dolomite	Calcium-magnesium carbonate	$CaCO_3.MgCO_3$
Ankerite	Calcium-iron carbonate	$CaCO_3.FeCO_3$

While the above formulas represent the end compounds, the natural minerals vary in composition by solid solution of the end members in each other. In the simple carbonates the miscibility seems limited. Siderite and rhodochrosite, of the simple carbonates, seem liable to variation in composition, but calcite is much less variable. There appears to be a complete gradation in the double carbonates between dolomite and ankerite. The minerals of this carbonate group do not occur in Idaho in good crystallizations nor as unusually fine specimens, but siderite and ankerite are widely distributed as gangue minerals in important ores and there seems to be some definite relationship between the composition of the gangue carbonate and the nature of the valuable minerals of the ore. For this reason the data in regard to the members of this group at hand are presented in some detail. Enough time has not been available to permit the making of a sufficient number of analyses, in advance of the preparation of this section, to permit of very definite conclusions, but it is hoped that the subject may be given more attention at a later date.

CALCITE (270)

Calcium carbonate, $CaCO_3$ Rhombohedral.

No localities furnishing unusually large or fine crystallizations of calcite are known in Idaho, the mineral occurring most commonly as a gangue mineral in ore-bearing veins or as limestone and marble. The localities noted by the writer are in part as follows:

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[22] Clyde P. Ross. A new copper district near Salmon, Idaho. Eng. and Min. Jour., vol. 118, No. 6, Aug. 9, 1924, pp. 205–208, 1924.

ADAMS COUNTY

In the Seven Devils district calcite in massive or granular form is common in the marble in which the ore deposits have been developed. A large specimen of vein material from the White Monument mine consists of large cleavage rhombohedrons of calcite, each of which serves as a core to a spherical layer of radial-fibrous calcite. The curved outer surface of these layers is drusy and formed by sharp calcite rhombohedrons which in turn are coated over with a thin layer of quartz crystals. The interspaces between the spheroidal masses of calcite are filled with a mixture of dead-black melaconite and green chrysocolla with a small amount of malachite.[23]

BANNOCK COUNTY

Very coarsely crystalline snow-white calcite occurs as the gangue of chalcopyrite and galena in ore from the Fort Hall mine, Fort Hall district.

Crystals of calcite occur with hematite in cavities in garnet-calcite rock from a locality on Lanes Creek, Bannock County, in NW. ½ sec. 9, T. 6 S., R. 43 E. These often show zoned layers of transparent material and buff calcite colored by included iron oxide. The habit of these crystals is shown in Figure 41 and the measurements made on them are given in the following table:

Measurements on calcite from Bannock County, Figure 41

Form		Symbol		Quality, description	Measured		Calculated	
No.	Letter	Gdt.	Miller		φ	ρ	φ	ρ
					° ′	° ′	° ′	° ′
1	*p*	+1	$11\bar{2}1$	Fair	30 00	44 36	30 00	44 36
2	κ	−1	$\bar{1}\bar{1}21$	Very poor	27 --	46 --	30 00	44 36
3	τ	$-\frac{13}{8}$	$\overline{13}.\overline{13}.26.8$	do	30 57	58 16	30 00	58 02
4	φ	−2	$\bar{2}\bar{2}41$	do	30 00	64 23	30 00	63 07
5	𝔤	−21	$\bar{2}\bar{1}31$	do	19 04	58 23	19 06	56 26
6	ℭ	−31	$\bar{3}\bar{1}41$	do	13 30	65 30	13 54	64 02

The faces are dull with the characteristic appearance of calcite and do not yield very exact measurements. The associated garnet and hematite are described elsewhere.

BLAINE COUNTY

In Blaine County calcite is reported to occur in the ores of the Hailey (Mineral Hill) district as cleavable masses and as combs of scalenohedral crystals in the ores.

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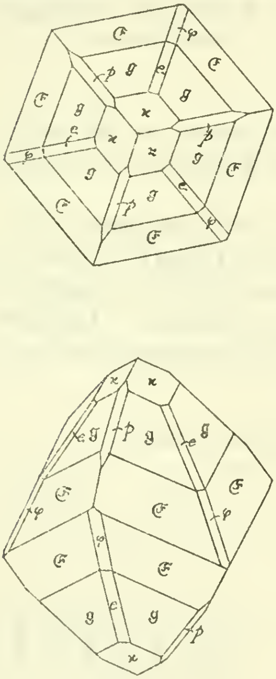
[23] Charles Palache. Amer. Journ. Sci., vol. 8, p. 301, 1899.

BOISE COUNTY

In Boise County calcite has been noted at a number of places. As a gangue mineral it has been noted in several mines of the Willow Creek district and it is abundant in the ore of the Friday mine.[24] The gangue in the Black Crook vein in the same district is quartz and pink calcite colored by manganese.[25]

In the Overlook mine, Pioneerville district, calcite forms well-developed transparent colorless crystals up to 1 cm. in length in a gold ore associated with quartz containing galena and pyrite. The forms present on the crystals, which are of the habit shown in Figure 42, are as follows (Dana notation): $m(10\bar{1}0)$, $a(11\bar{2}0)$, $v(21\bar{3}1)$, $r(10\bar{1}1)$, $y(32\bar{5}1)$, and $x(13\bar{4}1)$.[26]



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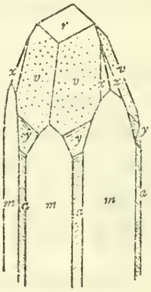

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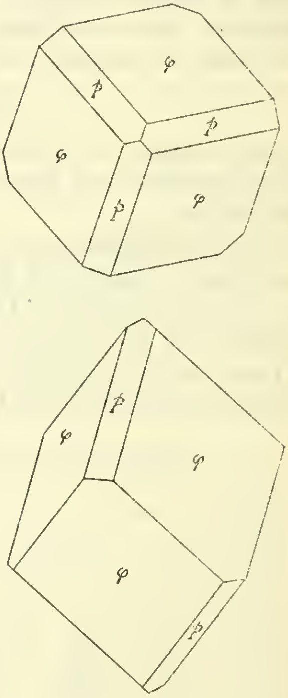

43

Figs. 41–43.—41, Calcite. Crystals associated with hematite and garnet, Bannock County. 42, Calcite. Overlook mine, Pioneerville district, Boise County. 43, Calcite. Associated with zeolites in basalt. Glenns Ferry, Elmore County

CUSTER COUNTY

In the Alder Creek district calcite occurs in both oxidized and primary ore of the contact-metamorphic copper deposits. In the primary ore it occurs both as veinlets and in vugs. It has not been observed in garnet rock that is clearly of porphyry derivation.[27] In the Bay Horse district calcite crystals have been noted lining cavities in the oxidized lead ore of the lead-silver deposits. In the Yankee Fork district calcite as a gangue mineral in the silver ores in associated with some quartz, chalcedony and opal, and is in the form of irregular areas and also as lamellar crystals of the variety described below as argentine. It is often largely replaced by quartz.[28]

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[24] Waldemar Lindgren. U. S. Geol. Survey, 18th Ann. Rept., pt. 3, p. 716, 1898.

[25] Idem., p. 717.

[26] Earl V. Shannon. Proc. U. S. Nat. Mus., vol. 58, pp. 412–413, 1920.

ELMORE COUNTY

Specimens from 5 miles below Glenns Ferry in Elmore County collected by C. F. Bowen in 1911 consist of vesicular basalt, the cavities of which are lined with amber crystals of calcite up to 5 mm. in diameter overlain by two white zeolites, probably chabazite and thomsonite. The calcites are relatively simple in habit and development, as shown in the drawing, Figure 43, and the forms present are only the two rhombohedrons $p(11\bar{2}1)$ and $\varphi(\bar{2}\bar{2}41)$. These gave the following angles:

Measurement of calcite, Figure 43, Elmore County

Form		Symbol		Quality, description	Measured		Calculated	
No.	Letter	Gdt.	Miller		φ	ρ	φ	ρ
					° ′	° ′	° ′	° ′
1	*p*	+1	$11\bar{2}1$	Poor	30 00	44 38	30 00	44 36
2	φ	−2	$\bar{2}\bar{2}41$	Very good	30 00	67 39	30 00	67 55

LEMHI COUNTY

Calcite occurs at a number of places in Lemhi County. A specimen from the Pittsburg–Idaho mine, Texas district, has been illustrated by Umpleby.[29] A crystal from this specimen was measured and is illustrated by the drawing, Figure 44. The forms and angles are as follows:

Measurement of calcite, Figure 44, Lemhi County

Form		Symbol		Quality, description	Measured		Calculated	
No.	Letter	Gdt.	Miller		φ	ρ	φ	ρ
					° ′	° ′	° ′	° ′
1	*f*	+½	$11\bar{2}2$	Poor	30 00	26 07	30 00	26 15
2	*k*	$+\frac{5}{3}$	$5.5.\overline{10}.2$	Very poor	30 00	67 39	30 00	67 55

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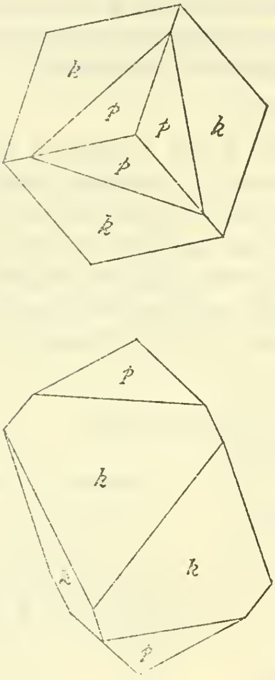
[27] J. B. Umpleby. U. S. Geol. Survey Prof. Paper 97, p. 50, 1917.

[28] J. B. Umpleby. U. S. Geol. Survey, Bull. 539, p. 85, 1913.

[29] J. B. Umpleby. U. S. Geol. Survey, Bull. 528, pl. 10, p. 64, 1913.

White granular calcite, with quartz, forms the gangue of auriferous pyrite in gold ore from the A. D. & R. mine in the Gibbonsville district. A specimen from the Parker Mountain mine, Parker Mountain district, contains small crystals of calcite associated with aragonite in cavities in psilomalane. These, as illustrated in Figure 45, are unusual in habit showing the forms ν ($\bar{5}.\bar{5}.10.4$) dominant with smaller faces of δ ($\bar{1}\bar{1}22$), $-\frac{3}{10}$ ($\bar{3}.\bar{3}.6.10$), $+\frac{1}{2}$($11\bar{2}4$) and *o*(0001). These gave the following measurements.



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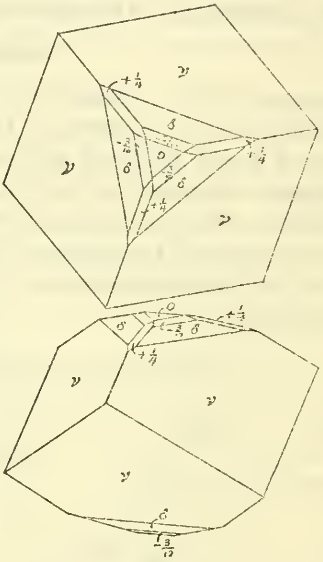

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FIGS. 44–45.—44, CALCITE. PITTSBURG-IDAHO MINE, LEMHI COUNTY. 45, CALCITE. FROM CAVITIES IN PSILOMELANE. PARKER MOUNTAIN MINE, LEMHI COUNTY

Measurements of calcite, Figure 45, Lemhi County

Form		Symbol		Quality, description	Measured				Calculated			
					φ		ρ		φ		ρ	
No.	Letter	Gdt.	Miller		°	′	°	′	°	′	°	′
1	*o*	0	0001	Very good	---	---	0	00	---	---	0	00
2	new(?)	$+\frac{1}{4}$	$11\bar{2}4$	Very poor	30	00	14	15	30	00	13	51
3	do	$-\frac{3}{10}$	$\bar{3}.\bar{3}.6.10$	do	30	00	16	35	30	00	16	29
4	δ	$-\frac{1}{2}$	$\bar{1}\bar{1}22$	Medium	30	00	26	09	30	00	26	15
5	ν	$-\frac{5}{4}$	$\bar{5}.\bar{5}.10.4$	Very poor	30	00	50	50	30	00	50	57

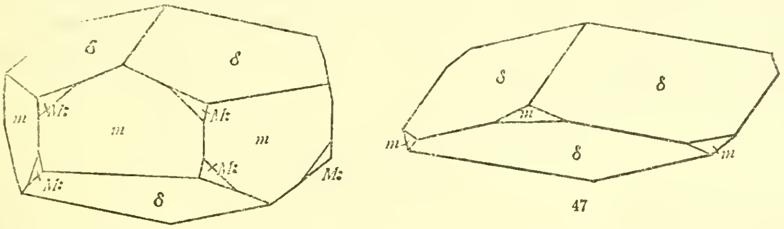
OWYHEE COUNTY

Although most of the calcite of Owyhee County silver veins is of the variety described below as argentine, a few crystals of the "nail head" habit illustrated in Figure 46 were found associated with quartz and adularia (valencianite) in cavities in massive epidote in a specimen from the Silver City district.

SHOSHONE COUNTY

Massive or granular calcite has been noted in a number of veins in the Coeur d' Alene district and a few specimens of well crystallized material have been found from time to time. As a gangue mineral granular calcite has been noted in the silver vein of the Yankee Boy mine on Big Creek and in the vein worked by the old workings of the Hypotheek mine near Kingston, where it is the gangue of pyrite and tetrahedrite.

Small open cavities in the ore of several of the larger mines have produced well-crystallized specimens of calcite, the form in each of the several occurrences observed being like shown in Figure 47, the flat rhombohedron $e(01\bar{1}2)$ (Dana notation) being the dominant form. These crystals often tend to aggregate in piles of individuals in approximately parallel position. Specimens showing piles of crystals up to 1 cm. in diameter, white and translucent, were obtained on the No. 13 level of the Bunker Hill mine. These occurred lining a crack and overlying masses of sphalerite. They were found by R. O. Jones in 1912 and all the specimens preserved were deposited in the Industrial Union cabinet in Kellogg. Crystals of similar habit and size but of a yellowish color were collected by Dr. F. L. Ransome in the Hecla mine in 1904. Measurements made on a crystal from the latter specimen furnished data for the drawing, figure 47. An open crack in one wall of the vein on the 2,000 foot level of the Standard-Mammoth mine, in 1915, was lined with groups of translucent colorless crystals of this habit aggregated into large groups, the individual crystals of which are 2 cm. across. An open crack on the 800 foot level of the Hercules mine was also lined by crystals up to 1 cm. across of the same habit, which were translucent and greenish in the interior and were opaque and brownish in the outer layer. These were partly coated with crystalline aggregates of pyrolusite.



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47

Figs. 46–47.—46, Calcite. Silver City district, Owyhee County. 47, Calcite. Hecla mine, Shoshone County

Small druses of crystals having this same flat rhombohedral habit have also been found in cracks in basic dikes at several places in the district. Such crystals were especially noted in the lamprophyric dike cut by the portal of the Lombardy tunnel in Italian Gulch north of Kellogg and in the large altered dike intersected by the Kellogg (No. 9) level of the Bunker Hill mine near the point where the tunnel crosses the Osburn fault.

In the Evolution prospect on the north side of the river, between Big Creek and Osburn, a large vein of solid calcite of a blue-gray to white or buff color is in places 30 feet wide. Numerous other occurrences of ordinary calcite have been observed. It seems probable that some of the massive carbonates which occur as gangue minerals, especially in the copper prospects in the Wallace and Prichard formations around the edges of the Coeur d' Alene district, which weather to a brown color and heretofore have been called siderite, are slightly ferriferous calcite. A specimen labeled "Black Bear Prospect, Taft Quadrangle," consists of coarse cleavage surfaces up to 4 cm. in diameter, of a buff-weathering white carbonate cut by later seams of chlorite, quartz, and chalcopyrite. The carbonate, upon analysis, gave the following results:

Analysis of calcite, Black Bear prospect

(E. V. Shannon, analyst.)

	Per cent
Insoluble (quartz)	0. 40
Calcium carbonate ($CaCO_3$)	96. 22
Magnesium carbonate ($MgCO_3$)	. 56
Iron carbonate ($FeCO_3$)	1. 86
Manganese Carbonate ($MnCO_3$)	1. 05
Total	100. 09

This analysis indicates that less than 3 per cent of iron and manganese carbonates in a calcite will cause the mineral to assume a distinctly brown color on weathering.

CALCITE, variety ARGENTINE

Although ordinarily calcite is characterized by a rhombohedral habit and the basal pinacoid (0001) occurs but rarely as a small and dull face, a variety of this carbonate of lime having a tabular or lamellar structure and made up of thin plates tabular to the basal pinacoid is known and has been described under the varietal name argentine. Argentine has been found at a number of places in Idaho and is of especial interest since the lamellar structure which characterizes much of the quartz of the Tertiary precious-metal veins is probably pseudomorphous after this variety of calcite. The following occurrences of calcite of the argentine habit have been observed.

CUSTER COUNTY

Calcite of the argentine variety is included in a number of specimens of mordenite and associated minerals from south of Challis, which were collected for the National Museum by Dr. Charles L. Kirtley, and which have previously been described in detail.[30] The largest specimen of this argentine has plates 16 cm. in diameter and, while containing quartz and analcite, shows no mordenite. A portion of this specimen with analcite crystals resting upon the argentine is shown in Plate 12, right. Another large specimen, which is shown in Plate 12, lower, is evidently a remnant from partial solution and consists mainly of argentine, including analcite, quartz, and mordenite. A third specimen, in which the platy character is not so evident, consists of a rounded cast of the central portion of a large geode and is coated on the outside with fibrous mordenite. When clean rhombic cleavages from the interior of this mass are dissolved in acid, long silky fibers of mordenite remain behind. The broadly platy specimens are snow-white in color. The characteristic pearly luster on the basal pinacoid, usually shown by argentine, is lacking, doubtless because the plates have a thin coating of reticulated quartz. A specimen in the National Museum from the Republic mining district, Washington, is identical with the Challis argentine in appearance and like it has the calcite plates coated with thin reticulated layers of quartz. The Washington argentine is associated with laumontite.

The large argentine specimens are clearly later in age than both the associated mordenite and the spherulitic quartz, but the argentine is older than the reticulated quartz and analcite which rest upon it. In the specimen of mordenite shown in Plate 10, lower, however, the calcite plates are embedded in the mordenite and thin sections show that the argentine plates are earlier than both the mordenite and the crust of small heulandite crystals which preceded the mordenite. Elsewhere in the mordenite specimens there are flat gashes now lined with analcite, which are apparently casts left by the removal by solution of early calcite plates. There are clearly two generations of the argentine calcite in these specimens from this locality. The tabular habit of the mineral may be due to the fact that the solutions from which it crystallized were highly saturated with silica and the calcite plates and their surfacing films of quartz are probably nearly contemporaneous, the silica presumably having deposited in colloidal form.

In the Yankee Fork district calcite occurs in the gangue of silver veins in volcanic Tertiary rocks. The calcite forms lamellar crystals, as well as irregular areas and in many places has been partially replaced by quartz. This replacement results in the usual hackly gangue quartz. The associated gangue minerals are quartz, chalcedony, and some opal.[31]

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[30] Clarence S. Ross and Earl V. Shannon. Mordenite and associated minerals from near Challis, Custer County, Idaho. Proc. U. S. Nat. Mus., vol. 64, No. 19, 1924.

OWYHEE COUNTY

As described under quartz, much of the ore of the De Lamar and other mines of the Silver City region is characterized by what is called lamellar, hackly, or pseudomorphous quartz. This is probably in all cases secondary after calcite of the argentine variety. The scarcity of calcite in the veins at present is noteworthy and only a very few specimens have been found showing any of the argentine not yet replaced. A single specimen collected by Lindgren consists of thick plates of calcite tabular to the basal pinacoid and arranged in cellular aggregates having exactly the structure of much of the platy quartz. Calcite occurs also in a specimen from a tunnel dump on the south side of Long Gulch below the Blaine tunnel. This specimen consists of brecciated basalt fragments surrounded by massive yellow-green epidote. The interstices of the breccia are lined with brilliant quartz crystals stained bright yellow at their bases. The latest deposit in the cavities is the calcite in thin white lamellar plates with pearly luster.

DOLOMITE (271)

Calcium-magnesium carbonate, $CaCO_3.MgCO_3$. Rhombohedral.

Dolomite, the double carbonate of lime and magnesia occurs both as a vein mineral and as bedded formations constituting dolomitic limestone and marble. Accurate identification of the mineral in veins, as distinct from other similar carbonates, usually requires analysis and identifications based upon superficial characters are only tentative. The following occurrences probably are but a small part of those in the State.

BEAR LAKE COUNTY

At the Blackstone mine in the Bear River Range crystalline gray dolomite forms the gangue of lead ores in limestone.[32]

BLAINE COUNTY

Dolomite probably occurs with other carbonates in a number of the mines of the Wood River district. A specimen from the North Star mine consists of a granular pale buff to cream colored carbonate inclosing black sphalerite and prismatic crystals of arsenopyrite. Small cavities are lined with curved rhombohedral crystals of the carbonate which is probably an iron bearing dolomite.

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[31] J. B. Umpleby. U. S. Geol. Survey, Bull. 539, p. 85, 1913.

[32] R. W. Richards. U. S. Geol. Survey, Bull. 470, p. 182, 1911.

BOISE COUNTY

Curved saddle-shaped crystals of opaque pale gray dolomite were seen with crystals of quartz and arsenopyrite in gold ore from the I. X. L. mine in the Pearl district. The ore consisted principally of quartz containing finely disseminated arsenopyrite.

BONNER COUNTY

The Cambrian limestone at Lakeview on the southern shore of Lake Pend d'Orielle is principally dolomite. At Bayview, where this rock has been metamorphosed, it is a pure dolomite marble, except in certain beds which are quarried and burned to quicklime.

CUSTER COUNTY

Dolomite is present in most of the limestone of the Alder Creek (Mackay) district, but it does not occur in the garnet contact rock with the ores, the magnesium here having been used up to form other minerals, principally diopside, during the earlier stages of the metamorphism.[32a] In northwestern Custer County dolomite occurs rarely as a gangue mineral in the lead-silver deposits.[33]

SHOSHONE COUNTY

Dolomite is mentioned by Ransome [34] as a gangue mineral in the Silver Cliff copper prospect east of Mullan. Recent examinations by the writer indicate that many of what have heretofore been called siderites in the area of copper prospects in the Wallace and St. Regis formations to the east and south of Mullan and also in the numerous prospects in the Prichard formation around Kellogg and on Pine Creek are mixed carbonates intermediate between dolomite and ankerite. These are commonly associated with quartz as the gangue of pyrite, pyrrhotite, or chalcopyrite. These carbonates usually show the characteristic rhombohedral cleavage of the group and in color, on fresh fracture, are white to pale buff or, more frequently, bluish or gray. When weathered for a year or more on the dumps they assume a pearly lustered ocher-brown color. There is represented a gradation from dolomite containing a small amount of iron, to ankerite containing relatively little magnesia, most of the specimens consisting of an intermediate mixture containing both iron and magnesia. Several gangue carbonates from the Mullan area have been analyzed and those from other parts of the region will be examined as opportunity permits. Those which have a molecular preponderance of magnesia over iron are here described as ferriferous dolomites. Those in which the reverse relation obtains are mentioned below under ankerite as are those which have not yet been analyzed.

[32a] J. B. Umpleby. U. S. Geol. Survey, Prof. Paper 97, p. 52-53, 1917.

[33] J. B. Umpleby. U. S. Geol. Survey, Bull. 539, p. 52, 1913.

[34] F. L. Ransome. U. S. Geol. Survey, Prof. Paper 62, p. 95, 1908.

A specimen of copper ore from the dump of the Copper Age prospect, selected as typical of the best ore, consists of coarsely crystalline dark-gray carbonate which is brown where it has weathered on the dump. This contains some interstitial blue-tarnishing chalcopyrite. There is a coating of fine scaly chlorite on one side of the specimen. The gray carbonate of this specimen, upon analysis, gave the following results and ratios:

Analysis of dolomite, Copper Age claim

[Earl V. Shannon, analyst]

Constituent	Per cent	Ratios	
Manganese carbonate ($MnCO_3$)	0.66	0.0058	0.4674
Iron carbonate ($FeCO_3$)	9.96	.0875	
Magnesium carbonate ($MgCO_3$)	30.80	.3741	
Calcium (lime) carbonate ($CaCO_3$)	58.58	.5973	.5973
Total	100.00		

The ratios between Mn+Fe+Mg to Ca=47 to 60 or 1.00 to 1.27, indicating some replacement of the essential magnesia of the dolomite by lime. The ratio of iron plus manganese to magnesia is 1 to 4.

The second analyzed dolomite came from the ore dump of the Monitor mine, the specimen being one collected by Mr. J. T. Pardee in 1910. It is mainly a coarse cleavable nearly white carbonate the crystals of which are partly separated by pale-green films of a scaly mica or chlorite. The carbonate contains some chalcopyrite. Upon analysis this afforded the following results:

Analysis of dolomite, Monitor mine

[Earl V. Shannon, analyst]

Constituent	Per cent	Ratios	
Manganese carbonate ($MnCO_3$)	0.54	0.0048	0.4848
Iron carbonate ($FeCO_3$)	8.11	.0713	
Magnesium carbonate ($MgCO_3$)	33.32	.4047	
Calcium (lime) carbonate ($CaCO_3$)	58.03	.5917	.5917
Total	100.00		

The ratio of the other bases to the lime is almost identical with the last, namely 48 to 60, while the ratio of iron plus manganese to magnesia is 1 to 5.32.

A second specimen from the Monitor mine collected from the dump by Mr. Calkins in 1912 is labeled "Carbonate and quartz." This consists of a coarse rhombohedral carbonate with distinct cleavage which is gray on fresh fracture and slightly yellow where lightly weathered. Quartz in large rude prisms lightly coated individually with a thin scaly green layer of chlorite penetrates the carbonate. A little white calcite is associated with the gray carbonate as though a later filling of small vugs in it. A few grains of chalcopyrite are inclosed in the quartz. Selected gray carbonate upon analysis gave the following results and ratios:

Dolomite, Monitor mine

[Earl V. Shannon, analyst]

Constituent	Per cent	Ratios	
Manganese carbonate ($MnCO_3$)	0.45	0.0040	0.4126
Iron carbonate ($FeCO_3$)	6.73	.0591	
Magnesium carbonate ($MgCO_3$)	28.77	.3495	
Calcium carbonate ($CaCO_3$)	64.05	.6531	.6531
Total	100.00		

The ratio of Mn+Fe+Mg to Ca is 1 to 1.58 and the ratio of Fe+Mn to Mg is 1 to 5.51.

The fourth dolomite analyzed is from the Manhattan prospect, 1½ miles northwest of the Monitor mine, which is located on a large vein of quartz and carbonate in which no commercial ore has been found.[35] The specimen consists of a carbonate in cleavage rhombs up to 2 cm. on an edge. The carbonate originally lined an open space subsequently filled with quartz, and although the original color of the carbonate was probably gray it is now brown from dump weathering. There are no ore minerals in the specimen. The carbonate, upon analysis gave the results which, recalculated after deducting quartz, are stated below.

Dolomite, Manhattan prospect

[Earl V. Shannon, analyst]

Constituent	Per cent	Ratios	
Manganese carbonate ($MnCO_3$)	0.24	0.0021	0.4399
Iron carbonate ($FeCO_3$)	10.79	.0948	
Magnesium carbonate ($MgCO_3$)	28.23	.3430	
Calcium (lime) carbonate ($CaCO_3$)	60.74	.6194	.6194
Total	100.00		

The ratio of other bases to lime is 1 to 1.41 and that of iron plus manganese to magnesia is 1 to 3.54.

A large enough series of analyses of the carbonates from these deposits would probably show a complete gradation from the ferriferous dolomites described above to the magnesian ankerites of the following section. Out of six thus far analyzed, 4 are classifiable as dolomite and 2 as ankerite; and a similar proportion of those not analyzed may belong to each group.

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[35] The prospects from which the above dolomites came have been described by F. C. Calkins and E. L. Jones, jr., U. S. Geol. Survey, Bull. 540, pp. 167-211, 1914.

ANKERITE (271A)

Calcium-iron carbonate, $CaCO_3.FeCO_3$. Rhombohedral.

Ankerite may be considered a dolomite in which the magnesia has been more or less completely replaced by iron, and every gradation is possible between a magnesia-free iron-lime carbonate and an iron-free magnesia-lime carbonate. While ankerite doubtless occurs in other parts of the State, its identity has been demonstrated by analyses only on specimens from the Coeur d'Alene region in Shoshone County.

SHOSHONE COUNTY

The occurrence of ankerite in Shoshone County has been outlined above under dolomite. Of a series of 10 gangue carbonates analyzed from south and east of Mullan, mostly from copper prospects, 3 were found to be siderite, 1 calcite, 4 ferriferous dolomite, and 2, while containing magnesia, had a preponderance of iron over magnesia, and hence can with propriety be called ankerites.

The first of these is from the upper level of the Carney copper prospect on Willow Creek, which has been described by Jones and Calkins.[36] The specimen was collected as typical ore by Mr. Calkins in 1912. It consists of a granular carbonate in grains 2 to 5 mm. in diameter showing good rhombohedral cleavage. The carbonate is white to faintly buff in color and contains abundant chalcopyrite and a few thin seams of quartz. The quartz is certainly later than the carbonate which it enters in cracks, and the chalcopyrite appears to replace the carbonate. The results obtained upon analysis of the carbonate, recalculated after deducting a little quartz, are as follows:

Ankerite, Carney copper prospect

[Earl V. Shannon, analyst]

Constituent	Per cent	Ratios	
Manganese carbonate ($MnCO_3$)	4. 38	0. 0388	0. 3744
Iron carbonate ($FeCO_3$)	26. 81	. 2356	
Magnesium carbonate ($MgCO_3$)	18. 29	. 2222	. 2222
Calcium carbonate ($CaCO_3$)	50. 52	. 5151	. 5151
Total	100. 00		

The ratio of Fe+Mn to Mg is 1 to 0.81, and that of Fe+Mn+Mg to Ca is 1.00 to 1.04.

The second specimen is from the Reindeer prospect and was collected from the dump in 1912 by Mr. Calkins. It is medium grained nearly white where fresh, but where slightly weathered is turning brown. It contains later replacing masses of chalcopyrite and a little of a gray sulphide, either tetrahedrite or chalcocite. Upon analysis this gave the following results:

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[36] F. C. Calkins and E. L. Jones, jr. U. S. Geol. Survey, Bull. 540, pp. 201–202, 1914.

Ankerite, Reindeer prospect

[Earl V. Shannon, analyst]

Constituent	Per cent	Ratios		
Manganese carbonate ($MnCO_3$)	2.72	0.0241	0.299	
Iron carbonate ($FeCO_3$)	31.32	.2752		0.507
Magnesium carbonate ($MgCO_3$)	17.12	.2080	.208	
Lime carbonate ($CaCO_3$)	48.84	.4980	.498	.498
Total	100.00			

The ratio of Mn+Fe to Mg is 1.00 to 0.69, and that of the other bases to lime is 1.00 to 0.98.

While it is not practical to differentiate in the field between magnesian ankerite and ferriferous dolomite, it is practical and possible to separate the members of the ankerite-dolomite series from siderite and for field use the name ankerite may be used for the magnesian series. They differ from the siderites in their white to grayish color when fresh, whereas the true siderite is always a clean light buff on fresh fracture. Upon weathering the siderites become dark brown to black, depending upon the manganese content, while the ankerites become pearly golden brown. Finally, when completely oxidized the siderites give a dark brown to black manganiferous limonite, while the ankerites yield a light brown ocher.

The ankerites of the Mullan area occur in veins in the Wallace and St. Regis formations. Ankerite has been noted in quartz stringers in the Wallace formation in the Florence (Dallaire) prospect on Elk Creek east of Kellogg and in the Hill and other prospects in the Wallace formation in Slaughterhouse Gulch at Wardner. It also occurs abundantly in numerous economically unproductive veins in the Prichard formation along the South Fork of the Coeur d'Alene River, between Osburn and Kellogg, where the carbonate is associated, in bluish quartz, with pyrite, pyrrhotite, and some chalcopyrite. Among the prospects of this group in which ankerite has been especially noted are the Enterprise claim of Fred Donaldson, between Big Creek and Gold Run, the Wisconsin and Teddy claims north of the river west of Moon Gulch, and the Evolution near Osburn.

In the Evolution ankerite occurred in a vein developed in the shaft, although the carbonate of the main vein exposed in the tunnel is calcite and not ankerite. In the Teddy this carbonate is prominent in some of the veins cut by the lower tunnel. In the Wisconsin (later called Gold Leaf Consolidated) prospect the ankerite occurs as granular masses which become brown on the dump and occasionally as small acute and curved rhombohedral crystals associated with quartz crystals lining small vugs in the vein. The carbonates of the ankerite series have also been seen in the Paymaster or Tillicum vein north of the mouth of Elk Creek, the Lucky Boy, south of

Bailey's Pond, and the Lombardy in Italian Gulch north of Kellogg. They probably occur as characteristic minerals in all of the veins of this group.

Ankerite also occurs in many of the veins in the Prichard formation in the Pine Creek Basin, in many of which it is associated with galena and sphalerite as well as iron sulphides and chalcopyrite. It has been seen in ore on the dumps of the Bobbie Anderson, Northern Light Amy-Matchless, and Shetland claims. A specimen from the Sherman mine contains crystals of ankerite up to 3 cm. in diameter, of a grayish color, and showing fine twinning striations. These are surrounded by scaly chlorite and contain cleavage cracks coated with films of pyrrhotite. The ankerite turns brown where weathered. Specimens from the Casey prospect in Bear Gulch, tributary to Pine Creek, contain granular gray ankerite in ore consisting of galena and sphalerite with pyrite in quartz. Small brown-weathering gray grains are associated, in quartz, with galena and chalcopyrite in ore from the Bobbie Anderson mine and similar ankerite occurs with galena and sphalerite in quartz in ore from the Spokane group.

While, in Shoshone County, the occurrence of siderite is somewhat local and is characteristic of the silver-lead ore bodies, and their neighborhood, the distribution of ankerite-bearing veins is more general, especially to the south and east. A large vein having the typical chalcopyrite-ankerite filling is mined for copper at the Amador mine on Cedar Creek south of Iron Mountain, Mont., 40 miles east of the Mullan area, and numerous similar veins occur in the intervening territory, while such veins are reported from numerous localities in the St. Joe and Clearwater Basins.

As regards the disseminated carbonates in the sedimentary rocks of the Coeur d'Alene region, no definite evidence has been accumulated, mainly because the existence of carbonate in them is only manifest after it has oxidized and no field work has been possible since the problem developed. Judging from the nature, color, and appearance of the oxidation products it seems probable, as concluded by Ransome and Calkins, that the abundant carbonate in the quartzites of the productive area of the mining district is siderite. The disseminated carbonate present in wide distribution in the Belt formations, the existence of which has been used by Hershey as evidence opposing certain conclusions of Ransome regarding ore genesis, is very probably ankerite or only moderately ferruginous dolomite.

SIDERITE (273)

BROWN SPAR, IRON SPAR, SPATHIC IRON

Iron carbonate, $FeCO_3$. Rhombohedral.

Siderite is, next to quartz, the most widespread and abundant gangue mineral in the State. It is especially characteristic of argentiferous lead ores where the valuable metallic minerals are galena and tetrahedrite, and it occurs thus in practically every lead producing district of consequence in Idaho. Siderite is also the essential gangue mineral of copper-silver ores in the Bayhorse district and of copper-gold ores in the Loon Creek district, both in Custer County.

BEAR LAKE COUNTY

Siderite forms a gangue of galena in the Blackstone mine, St. Charles district.[37]

BLAINE COUNTY

Siderite is reported to occur in the Camas district with quartz as the gangue of gold-bearing ores containing pyrrhotite, chalcopyrite, sphalerite, and a little galena.[38] In the Elkhorn district near Ketchum siderite forms the gangue of the ore of the Elkhorn mine.[39] In the Mineral Hill (Hailey) district siderite is a characteristic gangue mineral in the lead veins in slate, among them the Minnie Moore, Star, Mayflower, Red Elephant, O. K., Pass, Narrow Gauge, and other mines.[40] The siderite when fresh is buff in color, translucent, and coarsely crystalline. Siderite is also a characteristic gangue mineral in several districts of the Sawtooth quadrangle, particularly the Rosetta, Warm Springs, and Smoky districts,[41] where siderite together with quartz occurs as the gangue of argentiferous galena ores containing also some sphalerite, pyrite, and arsenopyrite. Typical coarsely crystalline translucent buff siderite occurs with galena in specimens of ore from the middle tunnel, Tyrannus vein. Other specimens examined include coarse cleavable buff siderite, weathering iridescent, from the Stormy Galore mine near Carrietown, and medium coarse granular buff siderite forming the gangue of galena, pyrite, and arsenopyrite from the Silver Star mine.

BOISE COUNTY

Buff siderite has been noted as the gangue of galena in ore from the lower tunnel of Hall Bros. property in the Deadwood district.

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[37] R. W. Richards. U. S. Geol. Survey, Bull. 470, p. 182, 1911.

[38] Waldemar Lindgren. U. S. Geol. Survey, 20th. Ann. Rept., pt. 3, p. 208, 1900.

[39] Waldemar Lindgren. Idem, p. 210.

[40] Waldemar Lindgren. Idem, p. 198–206.

[41] J. B. Umpleby. Ore deposits of the Sawtooth Quadrangle, Blaine and Custer Counties, Idaho. U. S. Geol. Survey, Bull. 580, pp. 221–249, 1915.

BONNER COUNTY

Coarse manganiferous buff siderite forms the gangue of tetrahedrite and pyrite in ores from the Little Joe or Keystone mine at Talache near Blacktail Mountain on the west shore of Lake Pend d'Oreille.

CUSTER COUNTY

In the Alder Creek (Mackay) district siderite is said to be the gangue mineral in a lead-bearing vein opened from the Darlington shaft on the Empire Group.[42] In the Bay Horse district siderite is the characteristic gangue mineral of the silver-copper ores, the chief valuable mineral of which is argentiferous tetrahedrite. The principal deposits of this type are the Ramshorn and Skylark mines with numerous veins of lesser importance, notably the New Silver Bell, one of the Hoosier veins, and some small deposits near the head of Garden Creek.[43] Typical specimens of the ore from the Utah Boy No. 5 tunnel of the Ramshorn mine show fresh clean coarsely crystalline translucent buff siderite as the gangue of massive tetrahedrite. Small vugs contain minute crystals of siderite, arsenopyrite, and tetrahedrite coated with mossy chalcopyrite. In the Bay Horse district siderite also occurs as the gangue of galena in lead-silver mines, including the Red Bird, Excelsior, Beardsley, Riverview, Pacific, and Cinnabar mines. These ores are now largely oxidized.[44] Siderite also forms the gangue of galena in the Ella group on Kinnikinnick Canyon.

In the Loon Creek district siderite occurs as the gangue of galena in the Lost Eagle, Metcalf, and other mines. The principal occurrence of the iron carbonate in this district, however, is as the gangue of auriferous chalcopyrite in the copper-gold deposits of which the Lost Packer mine is the most important example. In this mine there are 3 principal ore shoots in the south one of which siderite is the predominating gangue mineral.[45] The siderite is coarsely granular and pale buff in color.

FREMONT COUNTY

A specimen of ore from the 125 foot level of the Old Scott mine of the Birch Creek Mining Co., Kaufman district, consists of galena in granular buff siderite.

LEMHI COUNTY

In Lemhi County siderite has probably been the important gangue mineral of the lead-silver ores, but in the ores now mined it has been largely destroyed by oxidation. Specimens have also been reported from the Blackbird and Blue Wing districts;[46] a specimens howing minute drusy crystals from the Blue Wing district is illustrated by Umpleby.[47]

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[42] J. B. Umpleby. U. S. Geol. Survey, Prof. Paper 97, p. 51, 1917.

[43] J. B. Umpleby. U. S. Geol. Survey, Bull. 539, pp. 31–33, 1913.

[44] J. B. Umpleby. U. S. Geol. Survey, Bull. 539, pp. 38–39, 1913.

[45] J. B. Umpleby. U. S. Geol. Survey, Bull. 539, pp. 94–95, 1913.

SHOSHONE COUNTY

Siderite is the most abundant and characteristic gangue mineral of the Coeur d'Alene lead-silver deposits and its presence as a replacement of quartzite constitutes a noteworthy feature of the ores. In the typical deposits the mineral is massive, the ordinary gangue of the Bunker Hill and Sullivan mine, for example, being a pale brown fine-grained aggregate of siderite not always distinguishable, at a casual glance, from the quartzite of which it is, in considerable part, a replacement. In the vicinity of the ore bodies all gradations may be observed from nearly pure massive siderite to a somewhat sericitic quartzite. Coarsely crystalline varieties or phases of the siderite are rarer and occur where the mineral is associated with vein quartz as a filling of open spaces.

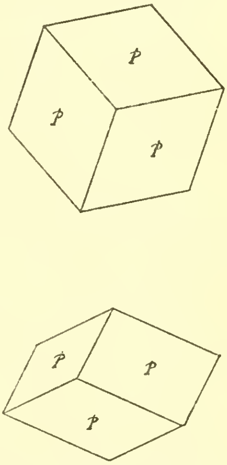

FIG. 48.—SIDERITE. UNIT RHOMBOHEDRON. GOLD HUNTER MINE, SHOSHONE COUNTY

Siderite is by no means equally abundant, even in all of the lead-silver mines. It is a particularly prominent constituent of the ores of the Wardner and Mullan groups. In the Canyon Creek group the mineral is fairly abundant in the Tiger-Poorman and Standard-Mammoth lodes, but in the Helena-Frisco and Hercules it is rather inconspicuous and in the Hecla mine occurs only sparingly as a microscopic constituent. The ores of the Ninemile Creek group apparently contain no siderite and it appears to be absent from the gold-quartz veins near Murray.[48] The siderite is practically all massive-granular but a few crystals of curved rhombohedral habit up to 3 or 4 mm. in size have been seen lining cavities in quartzite on the dump of the No. 2 tunnel of the Last Chance mine at Wardner and small translucent brown rhombohedrons line cavities in quartz in ore from the Gold Hunter mine. The latter are often filled with minute needles of boulangerite and perfect siderite rhombohedrons are sometimes found impaled in a boulangerite needle or embedded in fine wooly boulangerite. These are simple unit rhombohedrons as illustrated in Figure 48. The carbonate gangue of the lead-silver ores in quartzite is all siderite, but the galena-sphalerite ores in the

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[46] J. B. Umpleby. U. S. Geol. Survey, Bull. 528, p. 79, 1913.

[47] J. B. Umpleby. Idem, pl. 8 B, p. 72.

[48] F. L. Ransome. U. S. Geol. Survey, Prof. Paper 62, p. 97, 1908.

Prichard formation on Pine Creek contain a little ankerite and no siderite has been seen from any of these. In this respect they resemble the zinciferous ores in the Prichard formation of the Ninemile group. All of the siderites contain an appreciable amount of manganese carbonate and this seems highest in ores which are high in silver ratio and contain tetrahedrite. Some of the most translucent, brownest and most coarsely crystalline siderite of the district occurs in the narrow silver-rich veins in the Wallace formation between Kellogg and Wallace, where the siderite forms the gangue of argentiferous tetrahedrite. Typical of these veins are the Yankee Boy on Big Creek and the Polaris at the head of Polaris gulch. The siderites from these veins also seem highest in manganese carbonate although they have not yet been analyzed.

Although especially abundant near certain areas of intense mineralization, a carbonate supposed to be siderite is widely distributed through the quartzitic rocks of the district. Although the disseminated carbonate has a much wider distribution than the ores it is most abundant where the rocks have been most folded and fissured. It apparently forms more readily in some rocks than in others, being abundant in the Burke and in parts of the Prichard formation but rare in the calcareous rocks of the Wallace.

The siderite is visible in few weathered exposures, owing to its ready decomposition to limonite, consequently the presence of the carbonate disseminated in weathered rocks is indicated by rusty streaks and specks. In thin sections of the country rock the carbonate occurs in individuals, a majority of which are larger than the clastic grains of the rock, the mineral being crystallographically continuous for a diameter of several millimeters. Their form varies and while many of the larger grains appear ragged, close examination shows them to be determined in large part by rhombohedral planes. In other grains the rhombohedral form is more distinct, in some cases perfect, and in any specimen the rhombohedral crystal boundaries cut sharply across quartz grains establishing the fact that the carbonate developed by molecular replacement of the quartz rather than by filling cavities. The larger grains frequently inclose quartz grains and, much less commonly, scales of sericite. The carbonate therefore replaces the sericitic matrix of the rock more readily than the larger grains of quartz.[49] Disseminated iron-bearing carbonates which leave rusty pits when weathered occur in quartzitic rocks of the Belt series in wide distribution in the area surrounding the Coeur d'Alene district and remote from known mineralization. It seems probable that the same confusion obtains with regard to the disseminated carbonates as in the gangue carbonates of the veins and probably both ankerite and siderite occur also in disseminated form. It would not be surprising to find that the carbonate associated with folding and fissuring in the mineralized area is siderite and that the disseminated carbonate uniformly distributed in sedimentary beds remote from mineralizing influences is ankerite.

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[49] F. C. Calkins. Prof. Paper U. S. Geol. Survey, No. 62, p. 97, 1908.

The material has not been available for definite chemical research on the disseminated carbonates.

In addition to the siderite gangue of the galena ores of the producing mines there have long been mentioned great barren ledges of siderite or siderite veins carrying chalcopyrite making a copper ore usually too low grade for profitable exploitation. Umpleby and Jones[50] give especial attention to these and divide them into three groups, the southern area, south of South Fork of the Coeur d'Alene River; second, deposits in diabase along St. Joe River; and third, deposits north of the South Fork of the Coeur d'Alene River, principally along the Little North Fork of the river. The first group is the largest and out of 12 veins which are specifically described as typical large siderite veins, the Monitor, Richmond, Manhattan, Park, Reindeer Queen, Carney Copper, Vienna-International, Castle Rock, Smart Aleck, Horn Silver, Colusa, Black Diamond, and Palisade, the gangue carbonates from six have been analyzed. These are the Monitor, Richmond, Manhattan, Reindeer Queen, Carney Copper, and Castle Rock. Of these the first five named are ankerite-chalcopyrite veins, while the sixth, the Castle Rock, on Placer Creek, is a siderite-galena vein. There must be two kinds of carbonate veins represented in this area. The Vienna-International, Smart Aleck, and Horn Silver probably also belong to the siderite type. The Palisade, Colusa, and Black Diamond at the head of Pine Creek probably also are siderite veins to judge from their high manganese content.

The writer is not familiar with the prospects along the St. Joe River and has not examined specimens from the deposits mentioned in this area in the report above cited. Two specimens from this area which were analyzed proved to be ankerities.

Regarding the nature of the gangue in the prospects on the Little North Fork, little definite information is available. No specimens of primary ore from the Empire (formerly Horst-Powell) mine have been available for examination. The writer, in a brief examination of the Hamburg-American and Handspike claims, saw no carbonate. Large specimens of a carbonate from the Riverside have the appearance of siderite.

While the writer does not favor the minor refinements of vein classification which subdivide a period of mineralization into a large number of stages, yet, in the present state of knowledge it seems that, in so far as the large carbonate veins are concerned, we must divide these into two types—a class of ankerite (including ferriferous dolomite)—chalcopyrite veins for which, taking a name from the oldest and most important mine of the type, at Iron Mountain, Mont., we may designate the Amador type, and a class of siderite veins with tetrahedrite or galena, more closely allied to the valuable lead-silver veins of the Coeur d'Alene district. Disregarding variations in size and in relative proportions between gangue and valuable metallic minerals we may designate the latter the Yankee Boy type. Both of these may graduate, by different paths, into the typical Coeur d'Alene lead-silver deposit.

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[50] J. B. Umpleby and E. L. Jones, jr. Geology and ore deposits of Shoshone County, Idaho. U. S. Geol. Survey, Bull. 732, pp. 110–115, 1923.

The siderite is easily destroyed by oxidation, yielding gossans of limonite more or less darkened by manganese oxide.

The siderites and other carbonate minerals from this region are being analyzed from time to time in the Museum laboratory, and such analyses as have been completed to date are here stated.

A specimen from the Castle Rock property, south of Wallace, collected by E. L. Jones, jr., in 1912, consists of massive rather fine-grained buff to bluish siderite cut by later seams of quartz and containing thoroughly disseminated patches of chalcopyrite and tetrahedrite. The bluish color of a part of the carbonate may be due to finely disseminated sulphides. The analysis gave the following composition, recalculated to 100 per cent after deducting a little gangue.

Siderite, Castle Rock prospect

(Earl V. Shannon, analyst)

Constituent	Per cent	Ratios	
Manganese carbonate ($MnCO_3$)	5.11	0.045	
Iron carbonate ($FeCO_3$)	89.08	.723	0.828
Calcium carbonate ($CaCO_3$)	.68	.007	.069
Magnesium carbonate ($MgCO_3$)	5.13	.062	
Total	100.00		

This specimen is therefore predominantly iron carbonate with a moderate amount of manganese and magnesium carbonates and very little lime carbonate.

The second specimen analyzed and found to be siderite is a specimen from the Hemlock dump collected by Mr. Calkins in 1912.

This is a mass of moderately coarse granular buff siderite containing some later galena and a little pyrite and quartz. The analysis gave the following results.

Analysis of siderite, Hemlock claim

(Earl V. Shannon, analyst)

Constituent	Per cent	Ratios
Insoluble (quartz)	0.40	----------
Manganese carbonate ($MnCO_3$)	6.74	0.060 } 0.684
Iron carbonate ($FeCO_3$)	71.04	.624 }
Magnesium carbonate ($MgCO_3$)	19.86	.241
Calcium carbonate ($CaCO_3$)	.96	.010
Total	99.00	

Although rather higher than the last in magnesia, this is also definitely classifiable as siderite.

RHODOCHROSITE (274)

Manganese carbonate, $MnCO_3$. Rhombohedral.

Manganese carbonate is much rarer in Idaho than the other members of the group previously discussed. The following occurrences have been noted. Few analyses of the gangue carbonates have been made, however, and, should rhodochrosite occur in some color other than the usual pink it would probably fail of recognition.

BLAINE COUNTY

A little of a pinkish carbonate, which is probably rhodochrosite, occurs as a gangue mineral in a specimen of silver ore from the Hub mine on Lava Creek, 2 miles southwest of Martin in the Lava Creek district.

A specimen of silver ore in the National Museum (Cat. No. 56536, U.S.N.M.) labeled "Neptune mine, Alturas County," contains rhodochrosite. Alturas County no longer exists, having been divided into Elmore and Blaine Counties. The exact location of the Neptune mine has not been determined. The specimen, which is about 1 pound in weight, is nearly half rhodochrosite, the balance being coarse white quartz which contains coarse granular sphalerite varying abruptly from black to yellow in color, and some pyrite. The rhodochrosite is fine granular and light pink in color.

KOOTENAI COUNTY

Rhodochrosite occurs in the Conjecture mine of the Lakeview Silver Mining Co. south of the town of Lakeview at the southern tip of Lake Pend Orielle. The specimens were collected by Edward Sampson of the United States Geological Survey from the dump, the mine being flooded at the time of his visit in 1920. The ore of this mine consists principally of galena, some pyrite, and dark-colored sphalerite, and a little tetrahedrite. In places in the same vein system stibnite is found and in one place, quartz stringers containing wolframite. The gangue is mainly quartz, the rhodochrosite being subordinate in amount. Where found it is considered an indication of good ore. The carbonate is fine-grained and somewhat crushed and friable. It has a pale pink color which is only conspicuous when the mineral is moist. Upon analysis a selected and pure sample gave the following results, stated as carbonates of the respective bases.

Analysis of rhodochrosite, Conjecture mine

(E. V. Shannon, analyst)

Constituent	Per cent
Manganese carbonate ($MnCO_3$)	60. 26
Iron carbonate ($FeCO_3$)	12. 86
Calcium carbonate ($CaCO_3$)	11. 06
Magnesium carbonate ($MgCO_3$)	15. 48
Total	99. 66

Since manganese carbonate is clearly predominant this mineral is called rhodochrosite.

LEMHI COUNTY

Rhodochrosite is reported to occur in minute crystals on fracture surfaces in ores of the Kittie Burton mine in the Indian Creek district associated with malachite, azurite, and earthy oxides or iron and manganese.[51] Beautiful specimens of this carbonate have also been reported from the Blackbird district.[52]

SMITHSONITE (275)

DRY BONE

Zinc carbonate, $ZnCO_3$. Rhombohedral.

Smithsonite, the zinc carbonate usually known to miners under the name "dry bone," is often an inconspicuous earthy appearing mineral which is easily overlooked and may occur in the oxidized portions of many veins which contain primary zinc sulphides. It has been identified at a few localities in Idaho as given below.

BLAINE COUNTY

Smithsonite is common in the surface ores of several mines in Blaine County. The Kusa Mining Co. shipped several carloads of high-grade zinc carbonate ore in 1918 from claims on Boulder Creek in the Wood River Region.[53] Small botryoidal crusts of gray to pale green smithsonite occur in prospects high on the mountain south of Trail Creek near Ketchum. In the Era district smithsonite occurs with cerusite and silver minerals in the Ella mine near the head of Ella Canyon.[54]

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[51] J. B. Umpleby. U. S. Geol. Survey, Bull. 528, p. 138, 1913.

[52] J. B. Umpleby. Idem, p. 78, 1913.

[53] Robert N. Bell. Mining Industry of Idaho. Rept. State Mine Inspector for 1918, p. 63.

[54] J. B. Umpleby. U. S. Geol. Survey, Prof. Paper 97, p. 121, 1917.

CUSTER COUNTY

Smithsonite occurs sparingly in the Starr-Hope mine in the Copper Basin district with iron oxide and partly oxidized galena.[55] The zinc carbonate is common also in the oxidized lead-silver deposits of the Bay Horse district where it has been found associated with calamine and lead and copper carbonates in the Beardsley, Pacific, Red Bird, and other mines. In the Beardsley mine sheaves of calamine crystals rest upon druses of smithsonite and in the Red Bird mine crystals of both calamine and fluorite rest upon crusts of smithsonite.[56]

FREMONT COUNTY

In the Birch Creek district smithsonite is a rare constituent of oxidized ore of the Birch Creek mine, 10 miles southeast of Kaufman.[57]

In the Dome district a vein of comparatively pure smithsonite crops out a short distance above the trail which joins the Johnson property, 2 miles northwest of the Wilbert mine, from the east. The smithsonite is exposed in a small pit only a few feet deep. The vein is about 14 inches wide and is inclosed in magnesian limestone. The smithsonite is yellowish gray in color and has a rough botryoidal and drusy surface, but its distinguishing characteristic is its great weight, which is 50 per cent greater than that of the adjacent limestone.[58]

LEMHI COUNTY

In Lemhi County smithsonite has been definitely reported only from the Texas district, where it is common in oxidized lead-silver ores as botryoidal linings in cavities and as stringers along joints, particularly in the Pittsburgh-Idaho mine. Specimens from this mine are illustrated by Umpleby.[59]

ARAGONITE (277)

Calcium carbonate, $CaCO_3$. Orthorhombic.

Aragonite is a dimorphous form of calcium carbonate having the same composition as calcite but differing in crystallization. It is much less common than calcite, and has been found only as a rarity in Idaho.

ADAMS COUNTY

Aragonite is listed by Livingston and Laney[60] as occurring in Adams County in the Contact metamorphic copper deposits of the Seven Devils district.

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[55] J. B. Umpleby. U. S. Geol. Survey, Prof. Paper 97, p. 105, 1917.

[56] J. B. Umpleby. U. S. Geol. Survey, Bull. 539, pp. 68-72, 1913.

[57] J. B. Umpleby. U. S. Geol. Survey, Prof. Paper 97, p. 119, 1917.

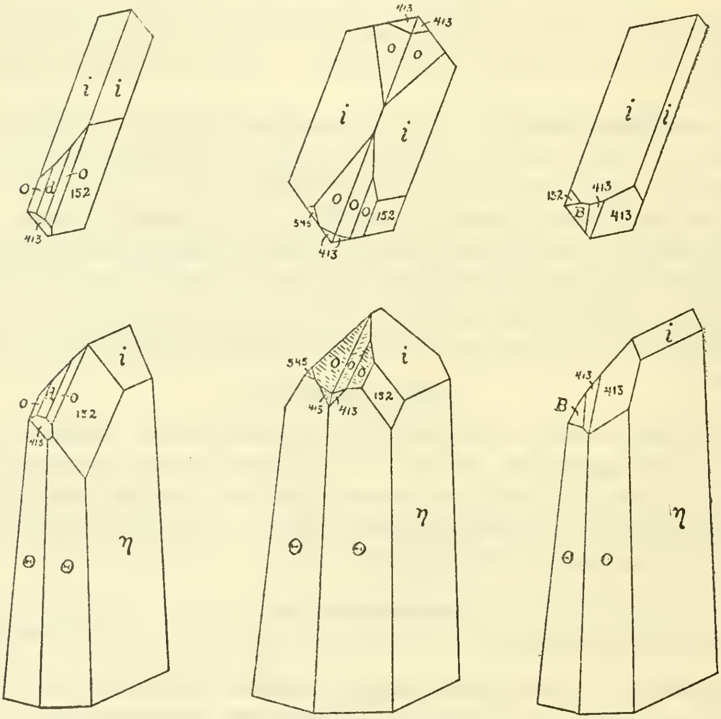
[58] J. B. Umpleby. U. S. Geol. Survey, Prof. Paper 97, p. 117, 1917.

[59] J. B. Umpleby. U. S. Geol. Survey, Bull. 528, pp. 96 and 103, pl. 10, 1913.

[60] D. C. Livingston and F. B. Laney. Idaho Bur. Mines Geol., Bull 1, p. 62, 1920.

BLAINE COUNTY

The best specimens of aragonite which have been seen from the State were collected by D. F. Hewett, of the United States Geological Survey, from a prospect on the west bank of Wood River between Bellevue and Hailey, a little north of the mouth of Mammoth Gulch. The aragonite crystals, which are transparent and colorless and average 2–3 mm. in length, occur implanted in cavities in spongy limonite. So far as could be determined these are untwinned. The habit is peculiar and, if the interpretation adopted is correct, they exhibit an odd symmetry and have several planes new for the species.



49 50 51

FIGS. 49–51.—ARAGONITE. WOOD RIVER DISTRICT, BLAINE COUNTY

Crystal 1, illustrated in Figure 49, is typical of the crystals of the specimen and shows the lack of symmetrical representation of the terminal planes. The determining faces of the elongation are the very steep pyramid Θ (10.10.1) and the orthodome η (0.24.1). The termination shows two faces of the dome i(021) and only one of d(102) while there are two faces in front of o(112) with no corresponding back faces. There is one face giving the indices (152) and one giving (413). The angles measured on this crystal are as follows:

Measurements of aragonite, Figure 49

Form		Symbol		Quality, description	Measured		Calculated	
No.	Letter	Gdt.	Miller		φ	ρ	φ	ρ
					° ′	° ′	° ′	° ′
1	θ	10	10. 10. 1	Medium	58 51	86 37	58 06	85 48
2	η	0. 24	0. 24. 1	do	0 00	88 06	0 00	86 41
3	*i*	02	021	Excellent	0 17	53 37	0 00	55 14
4	*d*	$\frac{1}{2}0$	102	Very poor	90 00	33 00	90 00	30 04
5	*o*	$\frac{1}{2}$	112	do	60 41	36 00	58 06	34 17
6	new	$\frac{1}{2}\frac{5}{2}$	452	Excellent	20 30	61 34	17 49	62 09
7	do	$\frac{4}{3}\frac{1}{3}$	413	Very poor	84 29	62 00	81 09	57 22

Crystal 50 is similar but stouter and, as shown in the drawing, has a peculiar reentrant angle at the summit. It shows the same forms plus a single face approximating the indices (545). This crystal gave the following angles:

Measurements of aragonite, Figure 50

Form		Symbol		Quality, description	Measured		Calculated	
No.	Letter	Gdt.	Miller		φ	ρ	φ	ρ
					° ′	° ′	° ′	° ′
1	θ	10	10. 10. 1	Excellent	58 13	85 49	58 06	85 48
2	η	0. 24	0. 24. 1	Very good	0 50	86 05	0 00	86 41
3	*i*	02	021	Excellent	0 09	53 41	0 00	55 14
4	*o*	$\frac{1}{2}$	112	do	58 08	35 46	58 06	34 17
5	new (?)	$\frac{1}{2}\frac{5}{2}$	152	do	19 26	61 31	17 49	62 09
6	do	$\frac{4}{3}\frac{1}{3}$	413	Fair	83 47	61 31	81 09	57 22
7	do	$1\frac{4}{5}$	545	Good	63 53	53 37	63 32	52 17

Crystal 3, shown in figure 51 is similar to crystal 1, but without *d*(102) and with one face of *B*(332). This crystal gave the following measurements:

Measurements of aragonite, Figure 51

Form		Symbol		Quality, description	Measured		Calculated	
No.	Letter	Gdt.	Miller		φ	ρ	φ	ρ
					° ′	° ′	° ′	° ′
1	θ	10	10. 10. 1	Poor, multiple	57 59	86 11	58 06	85 48
2	η	0. 24	0. 24. 1	Excellent	0 00	87 29	0 00	86 41
3	*i*	02	021	Very good	0 30	53 38	0 00	55 14
4	*B*	$\frac{3}{2}$	332	Very poor.	58 14	65 04	58 06	63 57
5	new (?)	$\frac{4}{3}\frac{1}{3}$	413	Medium	83 36	61 37	81 09	57 22
6	do	$\frac{1}{2}\frac{5}{2}$	152	do	19 52	61 53	17 49	62 09

In addition to the peculiarly unsymmetrical development there will be noted in the angle tables a marked and rather constant deviation of the measured from the theoretical angles. This may in part be due to the difficulty of orienting crystals of this habit for measurement on the goniometer and to the imperfect character of the crystals, but the consistent lack of agreement suggests rather a mineral of slightly different axial ratios. That the present mineral is aragonite and not another carbonate of the same group was established by qualitative tests, which proved the absence of barium, strontium, and lead. The faces measured are above referred to the nearest established form where possible. The previously undescribed forms here given are of doubtful authenticity. More material from the locality would be necessary to completely elucidate the peculiarities of this aragonite.

CUSTER COUNTY

Aragonite is found in the oxidized ore from the Beardsley mine-Bayhorse district. It forms sheaves of acicular crystals and coarse fibers associated with calcite. Some of the aragonite is associated with psilomelane, which occasionally has replaced it, giving pseudomorphous rosettes of psilomelane after aragonite.

LEMHI COUNTY

Aragonite occurs in the ore of the Pittsburg-Idaho mine, Texas district, as branching plant-like forms which show no measurable crystals. A specimen of this material is illustrated by Umpleby.[61]

CERUSITE (281)

Lead carbonate, $PbCO_3$. Orthorhombic.

Cerusite is second only to galena in importance as an ore mineral in the argentiferous lead ores of Idaho. It forms from the galena under the action of percolating ground waters and the amount of the ore which has been thus altered to cerusite varies greatly in different districts. Vast quantities of carbonate ores were mined from the Coeur d'Alene district, but these ores are largely exhausted in this district, but in the mining districts of the central and southern parts of the State cerusite is still more important than galena.

The oxidized ores are known to miners and operators of mines in the State as "carbonate ores." They vary greatly in appearance. When pure the cerusite is white or gray with a greasy luster, but much of the ore mined is greatly contaminated with silica and oxides of iron and manganese and varies through various shades of gray and brown to yellow or black. The appearance is often earthy and the only index to the lead content is the high specific gravity. In addition to the iron and manganese oxides, there often occur, with the cerusite, yellow ocherous lead antimonate, bindheimite, and blue and green carbonates of copper, azurite, and malachite.

In cavities in the massive cerusite there very frequently occur crystals, often very brilliant in luster and colorless or white. The cerusite crystals present a great variety of form and most of them are twinned in groups. These are the "crystallized lead" of the miners who never refer to the crystals as carbonate. Although it is manifestly impossible to list all of the occurrences of so widely distributed a mineral, a number of those which have been brought to my attention are mentioned below. A number of crystals were measured and, although they present no especial peculiarities, the measurements are reproduced with figures of many of the crystals merely to record the habits and developments of cerusite from the several localities, since crystals from the State have never before been described. An exhaustive treatment of the crystallography of the cerusite, especially of the Coeur d'Alene district, would doubtless develop many facts of interest and might profitably be undertaken were the material available. In the present work only poor material has been at hand, principally, the crystals being accidentally included in random ore samples.

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[61] J. B Umpleby. U. S. Geol. Survey, Bull. 528, pl. 10, 1913.

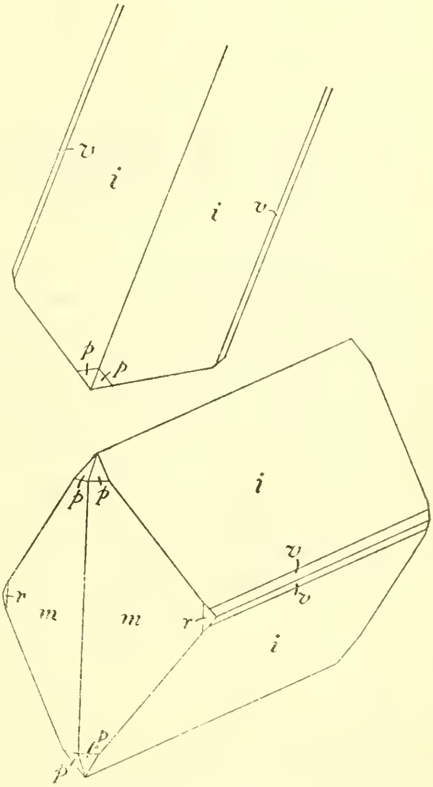

Fig. 52—Cerusite. Simple prismatic crystal elongated on the *a* axis. Golden Glow mine, Warm Springs district, Blaine County

BEAR LAKE COUNTY

In the St. Charles district in the Bear River Range cerusite of dark color surrounds crystalline aggregates of galena in a gangue of iron-stained limestone with some siderite.[62]

BLAINE COUNTY

Cerusite is common in the surface ores of almost every district of this county. It was formerly common in the Hailey region as massive ore and occasionally in groups of reticulated crystals. In the Era district cerusite is associated in the oxidized ores with small amounts of smithsonite, cerargyrite, and proustite.[62a] In the Birch Creek mine, Birch Creek district, the cerusite, which has a peculiar grayish-black color thought to be due to the manganese it contains, is associated with smithsonite, galena, anglesite, and a little wulfenite.[63]

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[62] R. W. Richards. U. S. Geol. Survey, Bull. 470, p. 182, 1911.

[62a] J. B. Umpleby. U. S. Geol. Survey, Prof. Paper 97, p. 121, 1917.

[63] Idem, p. 119.

A specimen labeled as from the croppings of the Golden Glow mine, Warm Springs district, consists of minute simple colorless cerusite crystals having the habit shown in the drawing, Figure 52, on spongy limonite. The measurements obtained on crystals from this specimen are given in the following table:

Measurements of cerusite (fig. 52) from Golden Glow mine

Form		Symbol		Quality, description	Measured				Calculated			
No.	Letter	Gdt.	Miller		φ		ρ		φ		ρ	
					°	′	°	′	°	′	°	′
1	*m*	∞	110	Excellent	58	44	90	00	58	37	90	00
2	*r*	∞3	130	Very poor, minute	28	16	90	00	28	39	90	00
3	*x*	0½	012	Very good, small	0	00	19	52	0	00	19	52
4	*i*	02	021	Excellent	0	00	55	22	0	00	55	20
5	*v*	03	031	Poor, narrow	0	00	66	13	0	00	65	15
6	*p*	1	111	Very poor, minute	58	52	55	37	58	37	54	14

A second specimen labeled as from Blaine County, but without more detailed locality, was probably from the Independence mine. It contained small cerusite crystals in cavities in galena. These were prisms elongated in the vertical direction and all twinned on the unit prism *m*(110), some of them greatly resembling quartz crystals as shown in Figure 54. The twinning is clearly shown in the crystals of the type shown in Figure 53, one of which was measured. This measured crystal gave the angles of the following table, each of the three crystals making up the twin being considered separately, the orientations being as shown in the drawing, Figure 53. The angles are for the normal position used for cerusite.

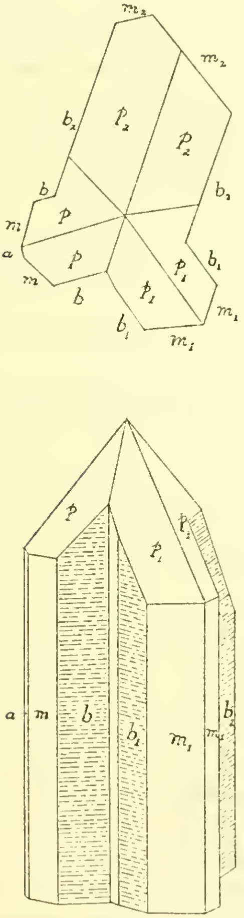
Measurements of twinned cerusite from Blaine County, Figure 53.

Form		Symbol		Quality, description	Measured				Calculated			
No.	Letter	Gdt.	Miller		φ		ρ		φ		ρ	
					°	′	°	′	°	′	°	′
1	*a*	∞0	100	Very poor	90	26	90	00	90	00	90	00
2	*m*	∞	110	do	61	10	90	00	58	37	90	00
3	*b*	0∞	010	Good	0	18	90	00	0	00	90	00
4	*p*	1	111	Very good	58	40	54	28	58	37	54	14
5	m_1	∞	110	Medium	60	44	90	00	58	37	90	00
6	b_1	0∞	010	Fair	1	32	90	00	0	00	90	00
7	p_1	1	111	Very poor	60	12	54	47	58	37	54	14
8	(?)	--------	--------	Good	7	26	90	00	----	----	----	----
9	m_2	∞	110	do	58	36	90	00	58	37	90	00
10	b_2	0∞	010	Poor	0	11	90	00	0	00	90	00
11	p_2	1	111	Excellent	58	30	54	06	58	37	54	14

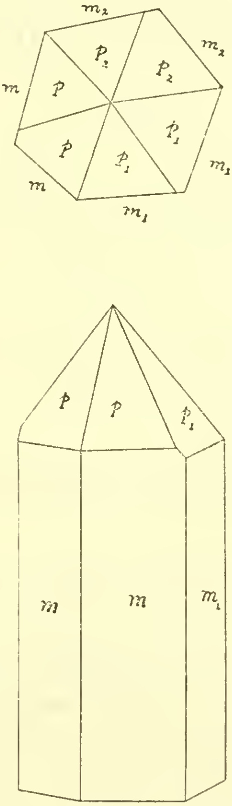
The three individuals of the twin bear the following angular relations to each other.

	°	′
v_0 (= v_0 of crystal 1) $\wedge$ $(v_1)_0$(= v_0 of crystal 2) =	120	34
$(v_1)_0$ (v_0 of crystal 2) $\wedge$ $(v_2)_0$(= v_0 of crystal 3) =	122	14
$(v_2)_0$(= v_0 of crystal 3) $\wedge$ (v_0) (= v_0 of crystal 1) =	117	12

The interpretation of such a twin is difficult, for example the face indicated on the figure by the letter b^2 may in fact be an extension of m^1 and similar alternatives exist for all of the prismatic faces. Time was not available for further study of the results on this crystal, but it is possible that a different interpretation might be found preferable. The results as given, identify the forms and establish the twinning plane as $m(110)$. They also serve to explain the hexagonal aspect of the examples like that illustrated in Figure 54, which is another case of the same twinning but without reentrant angles.


m2
m2
b2
p2
p2
b
b1
m
p
a
p
m
b
p1
b1
p1
m1
b1
m1
p
p1
p1
a
m
b
b1
m1
m1
b2

53


m2
m2
m
p
p2
p2
p1
p
p1
m1
m
m1
p
p
p1
m
m
m1

54

Figs. 53-54.—53, Cerusite. Independence mine, Blaine County. Vertically elongated twin on $m(110)$. 54, Cerusite. Same. Twin simulating quartz crystal

BOISE COUNTY

Cerusite is not rare in the oxidized gold ores of the Boise County gold mining districts. Much of the primary ore of the gold-bearing veins contains galena along with other sulphides, and in some cases the galena is highly auriferous. Where these veins are weathered the galena has been converted to cerusite, which is more or less mixed with limonite, and is frequently rich in spongy gold. It has been especially mentioned from the Wolf Creek area and from the Morning Star vein at Grimes Pass. Specimens from Hall Bros. property, Deadwood district, contain small colorless twinned cerusite crystals on limonite-stained rock and small gray to black crystals associated with pyromorphite on rusty quartz.

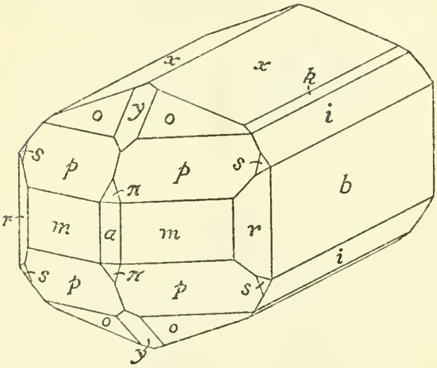


Fig. 55.—Cerusite. Simple prismatic crystal elongated on the *a* axis. Red Bird Mine, Bayhorse district, Custer County

CUSTER COUNTY

The carbonate is the most important ore of lead in Custer County, where it is mostly in earthy masses stained by iron and manganese oxides or in the granular form known as "sand carbonate." The latter forms friable coarse to fine sandy masses and results from the shrinkage due to decrease in volume of the ore during oxidation. The carbonate is especially prominent in the deposits of the Bayhorse district where it forms the ore of the Beardsley, Excelsior, Pacific, River View, Cave, and other mines.[64] This is mainly in the form of the friable incoherent material heavily impregnated with manganese and iron oxides, known as sand carbonate. Specimens which have been examined from the Red Bird mine consist of glassy masses of pure white cerusite embedded in limonite or surrounding residual cores of galena, forming high-grade ore. Some of the ore masses contain vugs which are lined with calcite and cerusite crystals. One simple prismatic crystal from this mine which was measured is shown in the drawing, Figure 55. This gave the following measurements.

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[64] J. B. Umpleby. U. S. Geol. Survey, Bull. 539, pp. 66–76, 1913.

Measurements of cerusite, Figure 55, Red Bird mine, normal position

Form		Symbol		Quality, description	Measured				Calculated			
No.	Letter	Gdt.	Miller		φ		ρ		φ		ρ	
					°	′	°	′	°	′	°	′
1	*b*	0∞	010	Excellent	0	00	90	00	0	00	90	00
2	*a*	∞0	100	Good	90	03	90	00	90	00	90	00
3	*m*	∞	110	Excellent	58	42	90	00	58	37	90	00
4	*r*	∞3	130	do	28	40	90	00	28	39	90	00
5	*x*	0½	012	Good	0	00	19	32	0	00	19	52
6	*k*	01	011	Fair	0	00	35	36	0	00	35	52
7	*i*	02	021	Very good	0	00	54	41	0	00	55	20
8	*y*	½0	102	Good	90	05	30	39	90	00	30	39
9	*π*	³⁄₂0	302	Very poor, minute	90	05	61	31	90	00	60	38
10	*p*	1	111	Very good	58	39	54	13	58	37	54	14
11	*o*	½	112	Good	58	39	34	42	58	37	34	46
12	*s*	12	121	Very poor	39	12	61	54	39	20	61	51

Although the Ramshorn mine has not mined much carbonate ore, some cerusite occurs in vugs. A specimen from this mine in the Museum (Cat. No. 56520, U.S.N.M.) contains colorless and white crystals of cerusite associated with mimetite and bayldonite in a vug in galena-tetrahedrite ore. The cerusite crystals vary from short prismatic parallel to the *a* axis to relatively thin tabular parallel to *b*(010). Some of the prismatic crystals are distorted by unequal development of corresponding faces of the brachydomes. One such, which was measured, gave the following angles:

Measurements of cerusite, prismatic type, Ramshorn mine, Custer County, normal position

Form		Symbol		Quality, description	Measured				Calculated			
No.	Letter	Gdt.	Miller		φ		ρ		φ		ρ	
					°	′	°	′	°	′	°	′
1	*a*	∞0	100	Good	90	00	90	00	90	00	90	00
2	*c*	0	001	Poor	--	--	0	00	--	--	0	00
3	*x*	0½	012	do	0	00	19	50	0	00	19	52
4	*i*	02	021	Fair	0	00	55	40	0	00	55	20
5	*v*	03	031	Medium	0	00	64	31	0	00	65	15
6	*y*	½0	102	Very good	90	00	30	43	90	00	30	39
7	*m*	∞	110	Poor	58	41	90	00	58	37	90	00
8	*r*	∞3	139	do	28	53	90	00	28	39	90	00
9	*s*	12	121	Excellent	39	16	61	58	39	20	61	51

Another crystal, one of the type tabular to (010) gave the following measurements:

Measurements of tabular cerusite crystal, Ramshorn mine, Custer County, normal position

Form		Symbol		Quality, description	Measured				Calculated			
No.	Letter	Gdt.	Miller		φ		ρ		φ		ρ	
					°	′	°	′	°	′	°	′
1	*a*	∞0	100	Excellent	89	58	90	00	90	00	90	00
2	*b*	0∞	010	do	0	00	90	00	0	00	90	00
3	*c*	0	001	do	--	--	0	00	--	--	0	00
4	*m*	∞	110	Fair	58	31	90	00	58	37	90	00
5	*r*	∞3	130	Excellent	28	39	90	00	28	39	90	00
6	*k*	01	011	Very good	0	00	36	01	0	00	35	52
7	*i*	02	021	Poor	0	00	55	30	0	00	55	20
8	*z*	04	041	do	0	00	70	30	0	00	70	55
9	*n*	05	051	Good	0	00	74	03	0	00	74	32
10	*y*	½0	102	Very good	90	19	30	.40	90	00	30	39
11	*p*	1	111	do	58	39	54	10	58	37	54	14

In the Copper Basin district cerusite is the principal valuable mineral of the ore of the Starr-Hope mine. A specimen of the best ore of this mine consists of platy waxy gray cerusite surrounding cores of galena.

FREMONT COUNTY

Cerusite is mined as oxidized lead ore in the Dome district, particularly in the Wilbert mine, where the galena of the disseminated ore in quartzite has oxidized to anglesite and cerusite. In the Skull Canyon district, cerusite, principally in the form of sand carbonate, is the most abundant mineral of the ore, particularly in the Kaufman and Weaver mine. Specimens of ore from this mine consist of massive cerusite in yellow ocher, of dull gray or iron stained masses, or of friable dull gray-brown sandy material mixed with a soft pulverulent lemon-yellow to greenish yellow mineral. The cerusite incloses anglesite and galena. In specimens from the Weimer copper mine cerusite occurs massive and as small white crystals twinned on *m*(110) associated with anglesite and some wulfenite surrounding kidneys of fine granular galena in a gangue of platy barite.

LEMHI COUNTY

In Lemhi County the carbonate is by far the most important of the lead minerals mined and forms the principal ore mineral in the Nicholia, Spring Mountain, and Texas districts.[65] The principal mine in the Nicholia district is the old Viola property which, in the years of greatest activity, 1886 and 1887, yielded lead bullion to the value of $1,000,000. This ore was lead carbonate with much iron and manganese oxides intermixed and ran from 30 to 60 per cent lead and 4 to 14 ounces of silver a ton.[66] A specimen from the Lena Delta mine, this district (Cat. No. 56532, U.S.N.M.) contains crusts and druses of grayish cerusite crystals lining cavities in ocherous limonite.

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[65] J. B. Umpleby. U. S. Geol. Survey, Bull. 528, p. 76, 1913.

[66] Idem, p. 84

In the Texas district the Pittsburg-Idaho and Latest Out mines in particular have produced large quantities of ore in which cerusite constituted the valuable mineral, mainly in the incoherent granular form mixed with iron and manganese oxides. The lead carbonate is also known to occur in numerous other mines and prospects of this district.[67] Specimens of ore from the Pittsburg-Idaho mine consist of massive cerusite containing cavities lined with simple prismatic and twinned crystals, the prismatic untwinned crystals being elongated, as is usual in cerusite, on the *a* axis. One such, which is illustrated in the drawing, Figure 56, gave the following measurements:

Measurements of simple cerusite crystal from Pittsburg-Idaho mine, normal position

Form		Symbol		Quality, description	Measured		Calculated	
No.	Letter	Gdt.	Miller		φ	ρ	φ	ρ
					° ′	° ′	° ′	° ′
1	*b*	0	010	Good	0 00	90 00	0 00	90 00
2	*a*	0	100	Fair	90 00	90 00	90 00	90 00
3	*m*	∞	110	Good	58 45	90 00	58 37	90 00
4	*r*	∞3	130	Excellent	28 45	90 00	28 39	90 00
5	*x*	0½	012	Very good	0 00	19 52	0 00	19 52
6	*n*	05	051	Medium	0 00	74 42	0 00	74 32
7	*p*	1	111	Fair	58 36	54 12	58 37	54 14
8	*s*	12	121	do	39 24	61 49	39 20	61 51
9	φ	13	131	Good	28 32	67 56	28 39	67 58

A twinned crystal which was measured is shown in the drawing, Figure 57. The relation between the two individuals of the twin is shown by the following angular relations:

$$V_o \text{ for crystal } 1 = 368°38' \ v_o$$
$$v_o \text{ for crystal } 2 = 245°50' \ (v_1)_o$$

$\frac{v_o \ (v_1)_o}{2} = 307° \ 14' - 90° = 217° \ 14' = v$ angle for the twinning plane, φ for which is then 28° 36′ showing the twinning plane to be *r* (130) calculated φ for which is 28° 39′. Of all of the twinned cerusite crystals from Idaho examined during the present work, those of this specimen are the only ones in which the twinning plane is other than *m*(110). A specimen from the bottom of the stope between the 300 and 400 levels, east vein, Pittsburg-Idaho mine is unusual in that it consists of pure compact gray massive cerusite containing abundant disseminated crystals of pyrite. Cerusite containing some iron oxide and residual galena from the Latest Out mine is black in color.

OWYHEE COUNTY

The rich oxidized ores formerly mined in the South Mountain district owed their value largely to cerusite as shown by old specimens preserved in the National Museum. Ore from the Golconda mine consists of greasy massive white cerusite containing some minute white crystals in cavities. This cerusite is associated with a little minium and bindheimite as an alteration product of coarse galena. Specimens from the Washington mine show massive cerusite associated with coarse galena in a limonite-stained rock and a specimen from the Rocksyfellow mine shows earthy cerusite with anglesite and bindheimite coating coarse cleavable galena. (Cat. No. 14882, U.S.N.M.)

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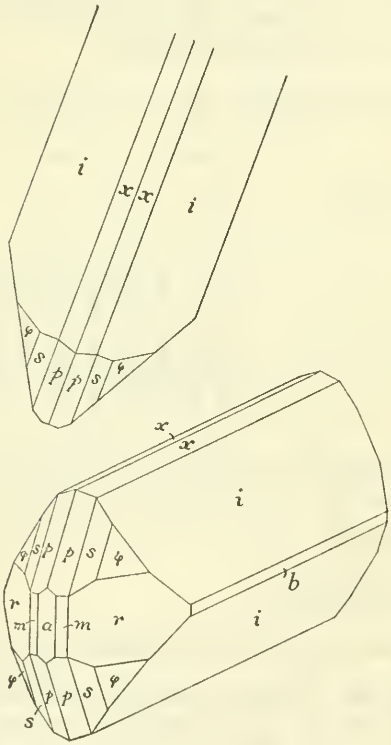
[67] J. B. Umpleby. U. S. Geol. Survey, Bull. 528, pp. 99-109, 1913.



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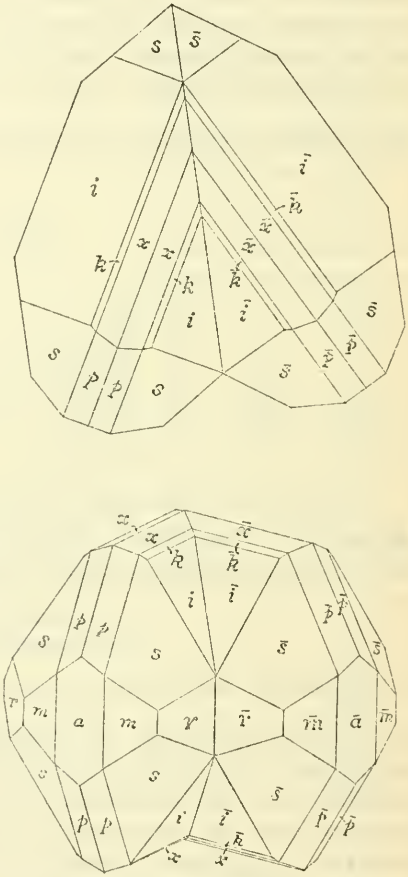

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FIGS. 56-57.—56, PRISMATIC CRYSTAL. PITTSBURG-IDAHO MINE, LEMHI COUNTY. 57, SIMILAR CRYSTALS TWINNED ON *ı*(130)

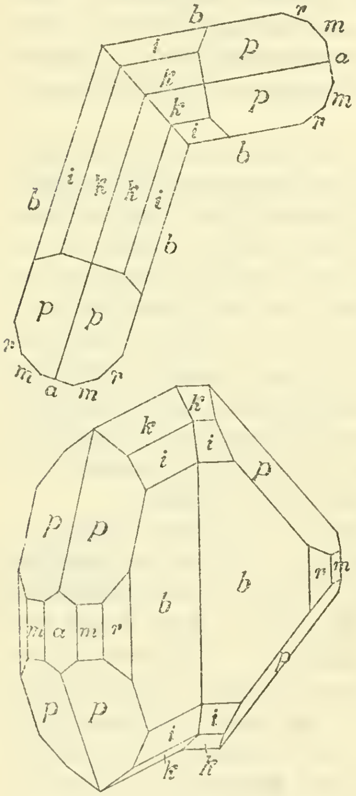
SHOSHONE COUNTY

In Shoshone County cerusite has been the most abundant and characteristic mineral of the oxidized ores, Great bodies of carbonate ore have been mined from the Morning, You Like, Mammoth, Standard, Tiger, Poorman, Hercules, Bunker Hill, Last Chance, Sullivan, Stemwinder, Tyler, Caledonia, Sierra Nevada, and other mines.

The ore of the oxidized zone is normally a relatively soft aggregate of massive cerusite, fragments of quartzite, and ocherous to compact limonite, with or without manganese oxides. There is usually more or less bindheimite mixed with the cerusite and rarely some azurite, malachite, linarite, plattnerite, pyromorphite, or anglesite. Cavities in the massive ore are lined with crystals of cerusite often of great delicacy and beauty. The crystallized cerusite is exceedingly variable in form and appearance. Single simple isolated crystals are rare, the mineral tending to form complex twinned aggregates. The carbonate ores are now largely exhausted and fine specimens of crystallized cerusite are rare although they are occasionally found in some of the newer mines or prospects or in lease workings in the old stopes of the large mines.

Certainly no other district in North America and probably none in the world has exceeded this region in the production of fine specimens of cerusite, both in quality and number, yet these are now practically unobtainable. They have all been lost or destroyed and practically none have found their way into the large collections or museums of the country and their existence has not, heretofore, been mentioned in the literature. In the days when carbonate ores were being mined almost every miner had a private cabinet filled with choice specimens in a corner of his home and many gorgeous crystallizations were on view in cigar cases, in hotels, boarding houses, and barrooms; and these could, in most cases, be had for the asking. Of late years, however, they have largely been lost to sight.

The first lead-silver ores mined were the ones which contained the greatest amount of carbonate and furnished the finest crystallized cerusite—in the years from 1882 to 1890. Such ores were still mined commonly up to 1900 and in 1901 the Hercules ore body began producing specimens of truly wonderful character. There was for several years, at the mouth of the No. 3 Hercules tunnel, a grotto walled up with logs and provided with shelves on all sides where specimens of crystallized cerusite, native silver, and pyromorphite weighing from 10 to 200 pounds each were placed and exhibited to visitors by candlelight. When this receptacle became crowded, and specimens were constantly being added, a quantity would be cleared out and thrown in powder boxes in the head house for anyone who wanted them to carry them away. The showier pieces, and the ones most esteemed locally, were the pure columnar masses or brilliant long-fibrous aggregates and the solid masses of reticulated plates. The latter are honeycomb-like masses of thin plates flattened parallel to *b*(010) and twinned on *m*(110) giving triangular intersections. Specimens showing crusts of small articulate crystals on gangue which would be highly acceptable to a mineralogist were hot highly regarded by the miners. The Hercules mine continued to furnish good cerusites for ten years after the other big mines—the Standard-Mammoth, Morning (including You Like), Last Chance, and the several mines of the Bunker Hill group—had begun deep workings in sulphide ores. Although the chief operations by the big mining companies were deep developments, leases granted in the old surface tunnels and stopes continued to produce carbonate ore and to furnish some good cerusite crystals intermittently down to the close of the war in 1918. Fine cerusite was produced by the McBride lease on the Tyler mine in 1912–1914 and during this period the Last Chance was mining above the No. 1 level and encountered some well crystallized material. The Sierra Nevada, on Deadwood Gulch, an old flat vein in which the ore, mined out in the early days of the district, was all oxidized, was reopened about this time by Drew Peeples, who reworked some of the old rejected material in the stopes and mined out some pillars of rich ore. Some exceedingly fine crystallized cerusite was found during these operations. In what was called the "square



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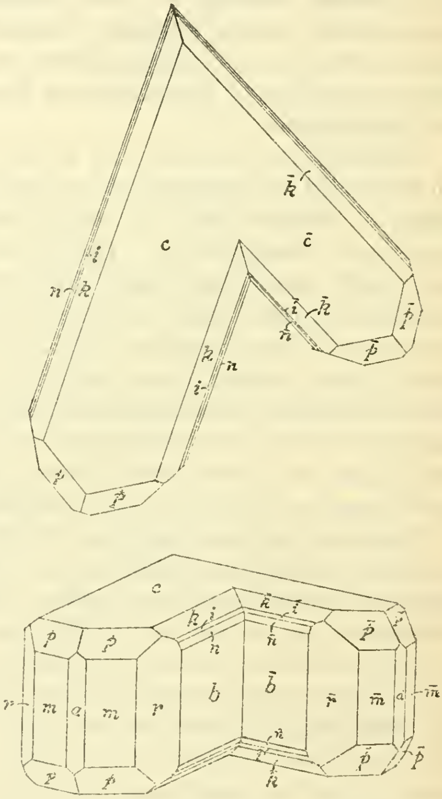

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FIGS. 58–59.—58, CERUSITE; BUTTERFLY TWIN. SIERRA NEVADA MINE, SHOSHONE COUNTY. 59, CERUSITE. TWINNED ON $m(110)$. CALEDONIA MINE, WARDNER, SHOSHONE COUNTY set stope" were found butterfly contact twins of colorless transparent cerusite up to 3 inches in greatest diameter. The illustration, Figure 58, is based on measurements made on one of the smaller crystals of this lot. Brilliant crusts of small twinned crystals ranging from colorless to gray and black or amber were common.

The Mammoth mine at Mace was reopened by a lease through the No. 2 Mammoth tunnel in 1913 and some cerusite ore obtained which contained some cerusite crystals as well as fine specimens of plattnerite and pyromorphite. These were aggregates of tabular crystals twinned on *m*(110). One such group, which is typical of much of the twinned cerusite of this and other mines, is shown in Figure 62. The main crystal of this group gave the following angles:

Measurements of cerusite from Mammoth mine

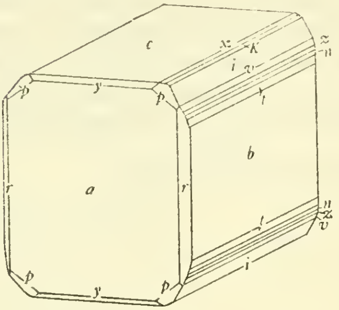
Form		Symbol		Quality, description	Measured		Calculated	
No.	Letter	Gdt.	Miller		φ	ρ	φ	ρ
					° ′	° ′	° ′	° ′
1	*c*	0	001	Very good	-------	0 00	-------	0 00
2	*b*	0∞	010	do	0 00	90 00	0 00	90 00
3	*a*	∞0	100	do	90 03	90 00	90 00	90 00
4	*m*	∞	110	Poor-narrow	58 39	90 00	58 37	90 00
5	*r*	∞3	130	Very good	28 36	90 00	28 39	90 00
6	*x*	0½	012	do	0 03	19 43	0 00	19 52
7	*k*	01	011	Very poor	0 03	35 55	0 00	35 52
8	*i*	02	021	Medium	0 03	55 30	0 00	55 20
9	*p*	1	111	Very good	58 37	54 12	58 37	54 14

This group illustrates the twinning which produces the large masses of reticulated plates. Much of the galena ore at the base of the oxidized zone contains cavities, from the removal of masses of siderite gangue which have cerusite crystals, usually water clear and colorless, implanted upon the unaltered sulphide. Some of these are simple and are difficult to distinguish from anglesite crystals which occur in the same manner. A relatively simple and untwinned crystal from a specimen of galena from the Last Chance mine, which is illustrated in the drawing, Figure 60, gave the following measurements:

Measurements of cerusite, Last Chance mine, Figure 60, normal position

Form		Symbol		Quality, description	Measured		Calculated	
No.	Letter	Gdt.	Miller		φ	ρ	φ	ρ
					° ′	° ′	° ′	° ′
1	*c*	0	001	Excellent	-------	0 00	-------	0 00
2	*b*	0∞	010	Very good	0 00	90 01	0 00	90 00
3	*a*	∞0	100	Excellent	90 00	90 00	90 00	90 00
4	*r*	∞3	130	Good	28 44	90 00	28 39	90 00
5	*x*	0½	012	do	0 00	19 59	0 00	19 52
6	*k*	01	011	Fair	0 00	35 50	0 00	35 52
7	*i*	02	021	Excellent	0 00	55 22	0 00	55 20
8	*vq*	03	031	Fair	0 00	65 28	0 00	65 15
9	*z*	04	041	do	0 00	71 01	0 00	70 55
10	*n*	05	051	do	0 00	74 33	0 00	74 32
11	*t*	06	061	Medium	0 00	76 24	0 00	77 01
12	*y*	½0	102	Good	90 00	30 36	90 00	30 39
13	*p*	1	111	Very good	58 46	54 18	58 37	54 14

A twinned group of crystals resting in a cavity in galena from the Last Chance mine is typical of many crystallized twinned groups from the district and is consequently illustrated as an example in the drawing, Figure 61. The averages of the angles measured on the several crystals of this group, are as given in the following table:



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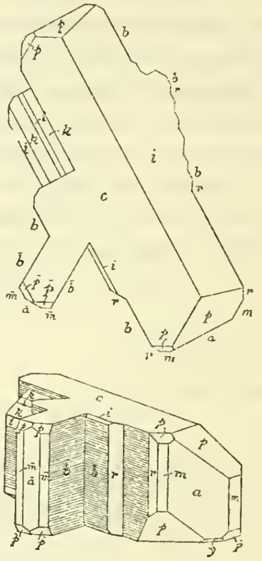


61

FIGS. 60–61.—60, CERUSITE. SQUARISH SIMPLE CRYSTAL FROM CAVITY IN GALENA. LAST CHANCE MINE, WARDNER, SHOSHONE COUNTY. 61, CERUSITE. CHARACTERISTIC GROUP TWINNED ON $m(110)$. FROM CAVITY IN GALENA. LAST CHANCE MINE, SHOSHONE COUNTY

Angles of crystal of cerusite, Figure 61, Last Chance mine, Normal position

Form		Symbol		Quality, description	Measured		Calculated	
No.	Letter	Gdt.	Miller		φ	ρ	φ	ρ
					° ′	° ′	° ′	° ′
1	*c*	0	001	Excellent		0 00		0 00
2	*b*	0 ∞	010	do	0 00	90 00	0 00	90 00
3	*a*	∞0	100	do	90 07	90 00	90 00	90 00
4	*m*	∞	110	do	58 36	90 00	58 37	90 00
5	*r*	∞3	130	do	28 24	90 00	28 39	90 00
6	*x*	0 ½	012	do	0 00	19 57	0 00	19 52
7	*k*	01	011	do	0 00	35 44	0 00	35 52
8	*i*	02	021	do	0 00	55 15	0 00	55 20
9	*y*	½0	102	do	90 00	30 37	90 00	30 39
10	*p*	1	111	do	58 42	54 16	58 37	54 14

The McBride-Morrell lease on the Tyler upper workings in 1912 encountered a small body of rich carbonate ore in which much fine crystalline cerusite appeared in places, mainly in the usual forms. These included coarse heavy columnar masses of brilliantly lustrous white material embedded in an ocherous impure manganese oxide; reticulated masses of platy crystals; and fibrous forms, often iridescent and steel-gray in color with metallic luster from thin outer coatings of manganese oxide. Other pure white masses of crystals were crusted with dendritic wires and moss-like masses of native silver. Some specimens, yellow from a thin outer coating of limonite, were made up of small model perfect six-rayed penetration twins. Workings of the Bunker Hill Co., penetrating the oxidized portion of the Tyler vein from below about this time disclosed fine cerusite, particularly in the Barney stope. Two stalactitic masses having a large botryoidal form were taken from this stope in 1915. These weighed nearly 100 pounds, were coated outside with limonite, but inside they consisted of pure white cerusite of fibrous structure. These were embedded in the concrete of the bridge crossing the flume on McKinley Avenue in the town of Kellogg. A large specimen of fibrous cerusite from this stope which laid for some years on the floor of a storeroom of the old Bunker Hill office at Kellogg contained included unoxidized masses of resinous brown sphalerite.

The Caledonia mine, opened through a shaft to the 300 and 500 foot levels, west of Wardner and on the east of Deadwood Gulch, in 1910 developed a rich body of carbonate ore and produced much cerusite prior to 1915 and yielded many excellent specimens, but much of the cerusite was massive and the yield of fine specimens was much smaller, in proportion, than in some other mines of the district. Some small clear glassy crystals were always to be obtained and a few large glassy twins in considerable aggregates were obtained embedded in clayey gouge. The usual columnar and "taffy-like" fibrous white specimens were obtained, sometimes colored green by an outer layer of malachite. Some small colorless to slightly smoky crystals obtained from cavities

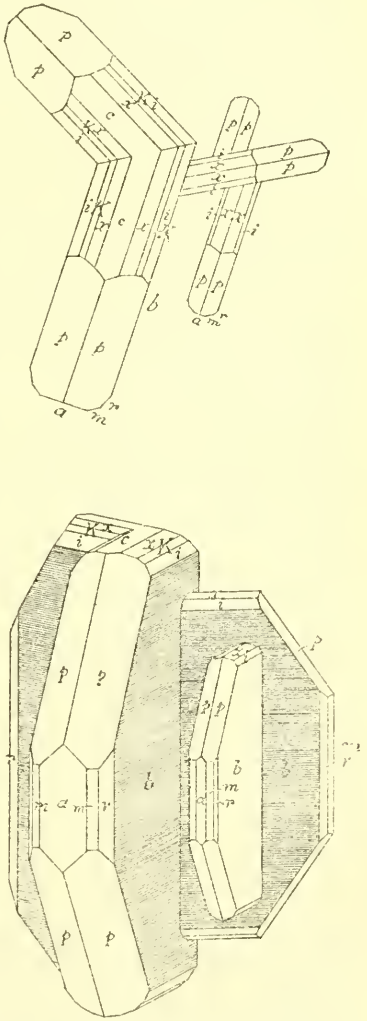


Fig. 62.—Cerusite. Characteristic group twinned on m (110). Mammoth mine, Mace, Shoshone County

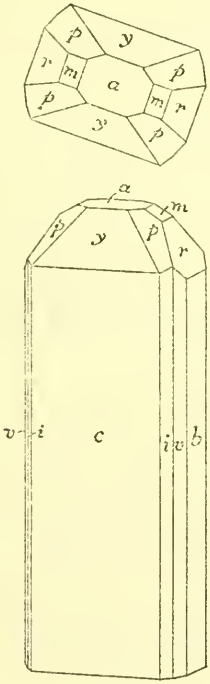
in leached quartz were mainly penetration and contact twins. One of these furnished the measurements which are the basis for the drawing, Figure 59.

Several of the various mines of the Bunker Hill group, other than the Tyler, namely the Stemwinder, Sullivan, and others, have produced large amounts of carbonate ore in former years in which were found cerusite crystals and crystalline masses of the types already described and lease workings in these mines have obtained good material in recent years.

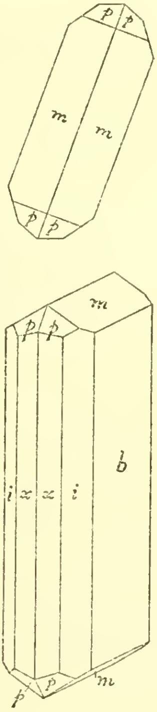
The Senator-Stewart mine had no very great quantities of oxidized ore and in such as they had pyromorphite was perhaps more prominent than cerusite, but some good specimens of crystallized cerusite were at times found in the upper tunnels, above the ore railway on the high mountain west of Deadwood Gulch.

A small mine, the Hypotheek, recently opened in French Gulch, 3 miles south of Kingston, has an unusually deeply oxidized ore body and has produced some very fine cerusite specimens, although the anglesite from this mine is still finer, as noted elsewhere. The usual forms of crystallized cerusite occurred in this mine, varying from colorless to pink and through various shades of gray to black. This black cerusite, which was noted at this and other mines of the district, was especially examined on a specimen from the Hypotheek mine to determine the cause of the black color, which has been variously explained as due to included unoxidized galena, manganese oxide, etc. The material gives a gray powder when finely ground. It dissolves in hot dilute nitric acid completely and the solution does not react for manganese except very faintly by the most delicate permanganate test nor does it contain any sulphur. The solution of the mineral in hydrochloric acid does not yield any hydrogen sulphide nor does it contain any iron. The mineral is not decolorized on heating nor yield any sublimate in the closed tube. These negative results show that the black color is not due to manganese, iron, lead sulphide, or organic matter. It seems possible that the color may be due to a small amount of microscopic disseminated lead dioxide, plattnerite, included in the cerusite. The most abundant crystals of cerusite from the Hypotheek mine were globular masses resembling a flattened cluster of grapes, pearly white in color, with a silky luster. These specimens, which were found in considerable numbers, embedded in soft limonite, were characteristic of the mine and differed from any specimens from elsewhere in the district.

The carbonate, in good specimens, has been reported from numerous mines on Pine Creek and specimens have been seen from the Highland Chief, Carbonate, Northern Light, and Lookout Mountain. The latter property, located on the high mountain west of the forks of Pine Creek, has been the most recent source for crystallized cerusite specimens. The management has, within recent years, shown a very gratifying interest in having the specimens preserved and has sent a number of lots to the National Museum, so that more crystals have been available for study from this mine than from all the rest of the Coeur d' Alene region during the preparation of this bulletin. As a consequence an unusual number of crystals from this mine have been measured and the various habits encountered are illustrated in the drawings, Figures 63 to 69, inclusive. The specimens have come from the oxidized portion of the vein which intersects the quartzite of the middle member of the Prichard formation. The minerals associated with the cerusite, including linarite, leadhillite, caledonite, bindheimite, and pyromorphite are described in their appropriate place in this report. The crystals vary from 1 mm. to 5 cm. in greatest diameter. They are for the most part colorless, but vary through amber and various tones of gray to the black material like that mentioned from the Hypotheek mine. The measured crystals may be described individually to show the range in crystal habit shown by the material which is more or less typical for the district.



63



64

FIGS. 63–64.—63, CERUSITE. SIMPLE PRISMATIC CRYSTAL. DRAWN WITH *a* AXIS VERTICAL. LOOKOUT MOUNTAIN MINE, PINE CREEK, SHOSHONE COUNTY. 64, CERUSITE. SIMPLE DARK-COLORED CRYSTAL DRAWN WITH *a* AXIS VERTICAL. LOOKOUT MOUNTAIN MINE

The first type which is well shown in the illustration, figure 63, is prismatic by elongation on the *a* axis, the usual elongation for cerusite, and they are attached by one end of the elongation. The crystals are minute and line cavities in massive impure cerusite which contains some admixed iron oxides, and malachite. The crystals are not twinned and they do not look like cerusite. In order to give a clearer idea of the habit and appearance of the crystals they are shown in the drawing, as they were measured, with the elongation vertical. The angles measured are stated for this orientation in the following table.

Measurements of cerusite, Lookout mine, Figure 63, a axis vertical

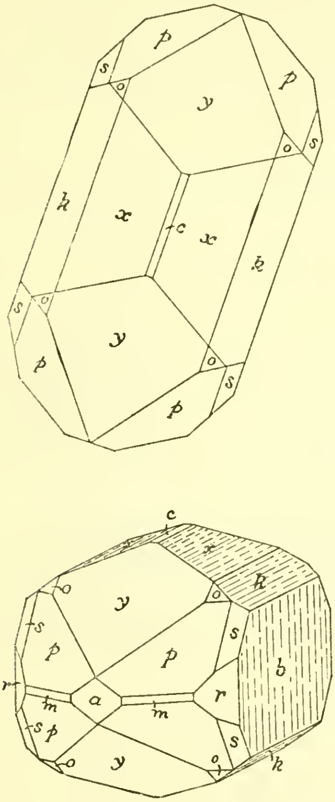
Form		Symbol		Quality, description	Measured		Calculated	
No.	Letter	Gdt.	Miller		φ	ρ	φ	ρ
					° ′	° ′	° ′	°
1	*c*	0	001	Good	90 43	90 00	90 00	90 00
2	*a*	∞0	100	do		0 00		0 00
3	*b*	0∞	010	Medium	0 00	90 00	0 00	90 00
4	*m*	∞	110	Excellent	0 09	31 26	0 00	31 23
5	*r*	∞3	130	do	0 09	61 23	0 00	61 21
6	*i*	02	021	Fair	34 41	90 00	34 40	90 00
7	*v*	03	031	do	24 47	90 00	24 45	90 00
8	*y*	½0	102	Excellent	90 01	59 40	90 00	59 21
9	*p*	1	111	Very good	54 47	46 22	54 08	46 09

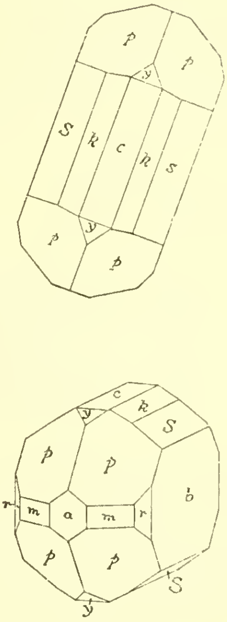
The second type of cerusite, illustrated in Figure 64, is relatively simple in development and occurs as small smoky gray crystals resting on leached quartz. These are in part simple and in part rayed twins and attached to them in parallel position are later brilliant colorless and more highly modified crystals. The simple crystals all have the habit shown in Figure 64, this crystal, like the last, being measured and drawn with the *a* axis vertical in order to better show its development. The angles measured, stated in the abnormal position as drawn, are given in the next table.

Measurements of cerusite, Lookout mine, Figure 64, a axis vertical

Form		Symbol		Quality, description	Measured		Calculated	
No.	Letter	Gdt.	Miller		φ	ρ	φ	ρ
					° ′	° ′	° ′	°
1	*c*	0	001	Very poor, narrow	89 51	90 00	90 00	90 00
2	*b*	0∞	010	Fair	0 06	90 00	0 00	90 00
3	*m*	∞	110	Excellent	0 10	31 53	0 00	31 23
4	*x*	0½	012	Fair	70 03	90 00	70 08	90 00
5	*p*	1	111	Very poor, dull	54 47	46 22	54 08	46 09

The more highly modified colorless prismatic crystals which appear as a later growth attached in parallel position to the preceding are illustrated in normal position in Figure 65. These are of small size and appear both as simple crystals and as contact and penetration twins on $m(110)$. The measurements obtained on the one illustrated in the drawing are given in the next table.





Figs. 65–66.—65, Cerusite. Stout, colorless crystal. Lookout Mountain mine. 66, Cerusite. Crystal moderately elongated on *a* axis showing ordinary forms. Lookout Mountain mine

Measurements of cerusite, Lookout mine, Figure 65, normal posiiton

Form		Symbol		Quality, description	Measured		Calculated	
No.	Letter	Gdt.	Miller		φ	ρ	φ	ρ
					° ′	° ′	° ′	° ′
1	*c*	0	001	Very poor, narrow	--------	90 00	--------	90 00
2	*b*	0∞	010	Very good	0 00	90 00	0 00	90 00
3	*a*	∞0	100	Excellent	90 00	90 00	90 00	90 00
4	*m*	∞	110	do	58 25	90 00	58 37	90 00
5	*r*	∞3	130	do	28 28	90 00	28 39	90 00
6	*p*	1	111	do	58 28	55 22	58 37	54 14
7	*o*	½	112	do	58 28	34 48	58 37	34 46
8	*s*	12	121	Fair	39 06	61 55	39 20	61 51
9	*k*	01	011	do	0 00	35 56	0 00	35 52
10	*x*	0½	012	do	0 00	19 51	0 00	19 52

Other specimens show simple, and more frequently, twinned colorless cerusite crystals up to 1 cm. in length, forming crusts on bleached quartzite. These are moderately elongated on the *a* axis. The simple crystals have the same habits as those making up the penetration twins. One of the simplest of these is shown in the drawing, Figure 66, and the angles measured on it are given, for normal position, in the following table:

Measurements of cerusite, Lookout mine, Figure 66, normal position

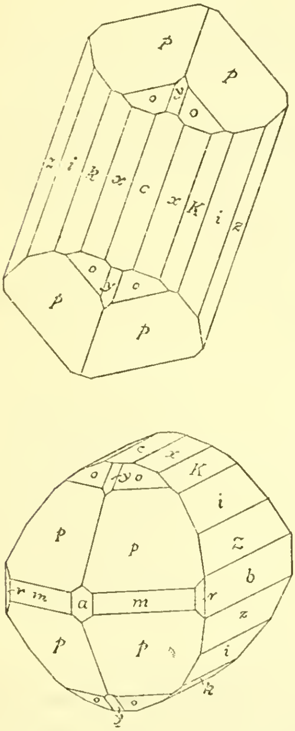
Form		Symbol		Quality, description	Measured		Calculated	
No.	Letter	Gdt.	Miller		φ	ρ	φ	ρ
					° ′	° ′	° ′	° ′
1	*c*	0	001	Good		90 00	--- 00	90 00
2	*b*	0∞	010	Very good	0 00	90 00	0 00	90 00
3	*a*	∞0	100	Excellent	90 14	90 00	90 00	90 00
4	*m*	∞	110	Good	58 30	90 00	58 37	90 00
5	*r*	∞3	130	Excellent	28 40	90 00	28 39	90 00
6	*k*	01	011	Good	0 05	38 32	0 00	35 52
7	*S*	$0^3/_2$	032	Very poor, striated	0 05	49 49	0 00	47 19
8	*y*	½0	102	Poor, faint	90 23	30 47	90 00	30 39
9	*p*	1	111	Excellent	58 52	54 18	58 37	54 14

A crystal from this lot of specimens similar to the last, but somewhat more modified, with the additional forms *o*(112), *x*(012), *i*(021), *z*(041), and *r*(130), is shown in the next drawing, Figure 67. The angles for this crystal are as given in the following table, the elongation (*a* axis) again being made vertical:

Measurements of cerusite, Lookout mine, Figure 67, a axis vertical

Form		Symbol		Quality, description	Measured		Calculated	
No.	Letter	Gdt.	Miller		φ	ρ	φ	ρ
					° ′	° ′	° ′	° ′
1	*c*	0	001	Good	90 05	90 00	90 00	90 00
2	*b*	0∞	010	Very good	0 06	90 00	0 00	90 00
3	*a*	∞0	100	Good		0 02		0 00
4	*m*	∞	110	Very good	0 00	31 24	0 00	31 23
5	*r*	∞3	130	Good	0 00	61 24	0 00	61 21
6	*x*	0½	012	do	70 05	90 00	70 08	90 00
7	*k*	01	011	do	54 10	90 00	54 08	90 00
8	*i*	02	021	do	34 42	90 00	34 40	90 00
9	*z*	04	041	do	19 02	90 00	19 05	90 00
10	*t*	06	061	do	13 05	90 00	12 59	90 00
11	*y*	½0	102	Poor	89 36	59 15	90 00	59 21
12	*p*	1	111	Excellent	54 09	46 06	54 08	46 09
13	*o*	½	112	Good	70 08	60 52	70 08	60 52

A third crystal of this series similar in most respects to the last has the additional forms *w*(211) and *s*(121), as shown in the drawing, Figure 68. This crystal contains the largest number of forms found on any cerusite crystal measured. The habit of the crystals is thus not marked by any great complexity and no unusual forms are present. The agreement between the measured and calculated angles is so close that there can be no reasonable question as to the correctness of the orientation and the identification of the forms. Many of the crystals are not simple individuals, but are made up of a large number of units in parallel position, but these are so exactly parallel that all of the faces, reflecting simultaneously, give a single perfectly sharp signal, permitting very exact measurements. The angles of the crystal of Figure 68, in normal position, are as follows:



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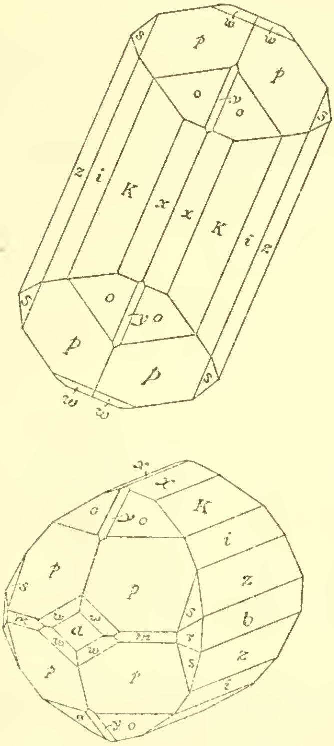

68

FIGS. 67–68.—CERUSITE. UNTWINNED COLORLESS CRYSTALS. LOOKOUT MOUNTAIN MIN

Measurements of cerusite, Lookout mine, Figure 68, normal position

Form		Symbol		Quality, description	Measured				Calculated			
No.	Letter	Gdt.	Miller		φ		ρ		φ		ρ	
					°	′	°	′	°	′	°	′
1	*a*	0	100	Excellent	90	06	90	00	90	00	90	00
2	*b*	0∞	010	Very good	0	00	90	00	0	00	90	00
3	*m*	∞	110	do	58	36	90	00	58	37	90	00
4	*r*	∞3	130	do	28	38	90	00	28	39	90	00
5	*x*	0½	012	Medium	0	00	19	38	0	00	19	52
6	*k*	01	011	do	0	00	35	44	0	00	35	52
7	*i*	02	021	do	0	00	55	15	0	00	55	20
8	*z*	04	041	do	0	00	70	04	0	00	70	55
9	*y*	½0	102	Very good	89	40	30	28	90	00	30	39
10	*p*	1	111	Excellent	58	38	54	11	58	37	54	14
11	*o*	½	112	do	58	20	34	27	58	37	34	46
12	*s*	12	121	Good	39	19	61	44	58	37	-------	
13	*w*	21	211	Excellent	73	01	67	56	58	37	-------	

Although even in the preceding crystals, which are shown in the drawings as simple crystals, twins are more abundant than single individuals, the solitary ones are drawn to lessen the labor of preparing the illustrations. The twins are penetration and contact twins and are thus similar to preceding illustrations of twinned groups, each individual of the group being like the one selected for illustration. Certain specimens from the Lookout mine show transparent contact twins of pale amber color up to 1 cm. in diameter, incrusting quartzite. These are of peculiar aspect and were interpreted with some difficulty. The habit is well shown in Figure 69. One of these gave the following measurements:

Measurements of cerusite, Lookout mine, Figure 69, normal position

Form		Symbol		Quality, description	Measured				Calculated			
No.	Letter	Gdt.	Miller		φ		ρ		φ		ρ	
					°	′	°	′	°	′	°	′
1	*a*	0	100	Very good	89	59	90	00	90	00	90	00
2	*b*	0	010	Excellent	0	00	90	00	0	00	90	00
3	*c*	0	001	Very good			0	00			0	00
4	*m*		110	Good	58	32	90	00	58	37	90	00
5	*r*	3	130	Excellent	28	34	90	00	28	39	90	00
6		0–	013	Excellent, striated	0	31	13	26	0	00	13	33
7	*x*	0½	012	Good	0	00	19	56	0	00	19	52
8	*k*	01	011	Excellent	0	00	35	55	0	00	35	52
9	*i*	02	021	Striated	0	00	53	57	0	00	55	20
10	*z*	04	041	Good	0	00	70	40	0	00	70	55
11	*n*	05	051	do	0	00	74	40	0	00	74	32
12	*p*	1	111	Poor, multiple	69	01	54	32	58	37	54	14
13	*o*	½	112	Excellent	58	40	34	49	58	37	34	46
14	*h*	¼	114	do	58	21	19	57	58	37	19	08

The twinning plane is established by the following angular relationships. v_o- of crystal 1 to v_o of crystal 2 will define the twinning plane. Since the pinacoids are not well shown by the drawing the plane common to both crystals may be established by the two faces of *r*(130) at the fore part of the figure. Thus

$$\frac{\text{v of } r \quad \text{v of } \bar{r}}{2} = 161^\circ\ 23' - 90^\circ = 71^\circ\ 23'$$

$$\text{v of twinning plane} = 71^\circ\ 23' - v_o \text{ of crystal } 1 = 58^\circ\ 42'$$

The twinning plane is thus the prism *m*(110), calculated φ for which is 58° 37′.

WASHINGTON COUNTY

In the Heath district many prospects show silver-lead ore containing cerusite. Specimens in the National Museum show massive cerusite from the Keystone mine (Cat. No. 60940, U.S.N.M.) in quartz with manganese oxide. Another specimen from the same mine contains earthy cerusite with anglesite and limonite coating very coarse-grained galena (Cat. No. 30198, U.S.N.M.).

MALACHITE (288)

Basic copper carbonate, $2CuO.CO_2.H_2O$. Monoclinic.

Green copper carbonate is one of the commonest of the secondary oxidation products, forming as large or small crusts or masses or as a conspicuous green stain where primary copper minerals have been exposed to the action of atmospheric agencies or meteoric water. Where present in any notable quantity the mineral usually forms globular or botryoidal crusts having an internal fibrous structure and banded green color. It also occurs frequently as aggregates of thin acicular fibers or needles. Where thinly distributed this mineral has great staining power and a rock may be colored a very vivid green by a very small percentage of copper in this form. Many localities for the mineral are known in Idaho and, while no dependable locality furnishing the mineral in fine specimens in large number is known, occasional good cabinet material has been found in most of the localities mentioned below.

ADAMS COUNTY

In the contact-metamorphic copper deposits of the Seven Devils district malachite is second only to chrysocolla in importance as an ore mineral in the oxidized ores. It is especially prominent in the Arkansaw-Decorah-Marguerite, Peacock, and South Peacock mines.[68]

BANNOCK COUNTY

In the Moonlight tunnel of the Pocatello Gold and Copper Mining Co. in the Fort Hall district, malachite occurs in beautifully radiating groups and in prismatic fibers forming tufts in quartz and in copper ore consisting of bornite largely altered to copper pitch.

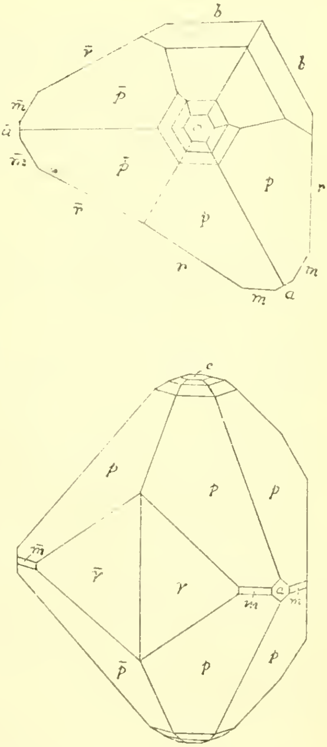

FIG. 69.—CERUSITE. CRYSTAL TWINNED ON *m*(110). LOOKOUT MOUNTAIN MINE

BEAR LAKE COUNTY

Malachite occurs in the Humming Bird mine in Paris Canyon in the Bear River Range as radially fibrous masses in the oxidized ore. In part the malachite is scattered through a jaspery quartz rock which is stained deep red by hematite. The rock takes an excellent polish and the green malachite and deep red hematite make a pleasing combination which may be suitable for use as a gem or ornamental stone.[69]

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[68] D. C. Livingston and F. B. Laney. Idaho Bur. Miner and Geol. Bull. 1, pp. 67–83, 1920.

BLAINE COUNTY

Malachite occurs in small amounts in the oxidized portions of many veins. Its most noteworthy occurrence in the county is in the Clyde district, where the green carbonate occurs in stains and crusts with azurite and chrysocolla making up the oxidized copper ore of the Copper Bluff prospect in Basinger Canyon northeast of Clyde.[70]

CUSTER COUNTY

In the Alder Creek (Mackay) district malachite is a persistent though subordinate mineral throughout the oxidized ores, where it occurs in intimate association with azurite, chrysocolla, brochanthite, and other secondary copper minerals. It is likely to be confused with brochanthite which, however, is duller green and does not effervesce with acid. The malachite commonly occurs as bunches of irregular form in the silicate ores and as crusts alternating with azurite in tabular and lenticular masses.[71] In the gold-copper deposits of the Loon Creek district, and the silver-copper mines of the Bayhorse district in the northwestern part of the county, malachite is common as a stain in the outcrops. In the Ramshorn and Hoosier mines it forms delicate green velvety crusts in cavities in partly oxidized tetrahedrite. In the Copper Basin district at the head of the east fork of Big Lost River malachite occurs with azurite as blebs, bunches, and veinlets in amorphous chrysocolla in the ore of the Parallel tunnel of the Reed and Davidson mine. On the 180-foot level on the shaft of the same mine the ore consists mainly of malachite both of light pea-green and dark emerald-green color, the darker occurring as crusts on the lighter and the whole concentrically arranged. Similar ore occurs in the Rosenkrans property.[72]

FREMONT COUNTY

In the Skull Canyon district malachite is the most conspicuous mineral of the ore of the mine of the Weimer Copper Co., 2 miles east of Kaufman, where it forms incrustations along fractures or beautiful needle crystals scattered through the finely vesicular portions of the vein and in the small vugs which occur sparsely in the firmer parts. It is contained in a gangue of hematite varying from soft ocher to hard jaspery material.[73] A specimen from this mine showing divergent emerald-green transparent prisms in cavities in limonite furnished measurable crystals, which supplied the data for the drawing, Figure 70. The prisms present the usual habit, elongated in the vertical direction and invariably twinned on the front pinacoid *a*(100). These are always developed with the reentrant angle up, as shown in the figure. The angles of the forms present, *a*(100), *b*(010), *m*(110), and *c*(001), agree well with the calculated values. The prism zone is deeply striated vertically.

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[69] U. S. Geol. Survey. Mineral Resources for 1909, pt. 2, pp. 804–805.

[70] J. B. Umpleby. U. S. Geol. Survey, Prof. Paper 97, p. 113, 1917.

[71] J. B. Umpleby. U. S. Geol. Survey, Prof. Paper 97, p. 54, 1917.

[72] J. B. Umpleby. U. S. Geol. Survey, Prof. Paper 97, p. 105, 1917.

[73] J. B. Umpleby. U. S. Geol. Survey, Prof. Paper 97, p. 112, 1917.

LATAH COUNTY

In the Hoodoo district malachite occurs as a constituent of oxidized copper ore in the Mizpah and Copper King mines. A body of good grade oxidized copper ore opened in the former property in 1917 contained abundant malachite with less azurite, native copper, cuprite, and copper pitch ore.[74]

LEMHI COUNTY

In Lemhi County malachite is mentioned from a large number of mines,[75] although no striking specimens of the mineral have been seen from the county. In the Blue Wing district malachite occurs locally in the oxidized ores along with other oxidation products of chalcopyrite in the veins which produce hubnerite ores. In the McDevitt district much malachite occurs, with a little azurite as an oxidation derivative of bornite near the surface in the Copper Queen mine. In the Carmen Creek district malachite occurs in similar association and similarly in the Queen of the Hills, John Torney, and other mines of the Eureka district and in the Blackbird district.

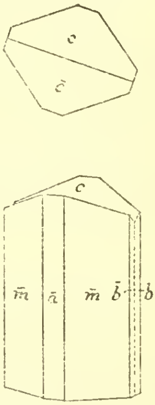

FIG. 70.—MALACHITE. CRYSTAL TWINNED ON *a* (100). WEIMER MINE, KAUFMAN DISTRICT, FREMONT COUNTY.

LEWIS COUNTY

Malachite occurs in oxidized ore of the Horseman property in the Deer Creek district.[76]

SHOSHONE COUNTY

In Shoshone County malachite is found in numerous places in the Coeur d'Alene and tributary districts. In the southern copper area malachite occurs in limonite in the Monitor, Richmond, and other mines. In the Snowstorm mine malachite was found in much of the oxidized ore as an impregnation in quartzite, but was probably much less abundant than chrysocolla. Malachite occurs locally in all of the oxidized lead-silver deposits associated with cerusite, having been noted in the upper levels of the Mammoth, Last-Chance, Hercules, and other lead mines. Radial bunches and small mammillary masses occurred in oxidized lead ore in the Sierra Nevada mine in Deadwood Gulch and in the lead-copper ore of the Caledonia mine. In the latter mine, which produced more malachite than any other lead mine in the district, much of the malachite formed a green impregnation in quartzite surrounding other copper minerals. Fibrous or mammillary green forms occurred with cerusite and cuprite and delicate acicular crystals were found in spongy masses of limonite. Occasionally pearly crystals of cerusite were stained a delicate green by a thin outer layer of malachite.

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[74] D. C. Livingston and F. B. Laney. Idaho Bur. Mines, and Geol. Bull. 1, pp. 95–96, 1920.

[75] J. B. Umpleby. U. S. Geol. Survey, Bull. 528, pp. 110, 121, 157, 158, 1913.

[76] D. C. Livingston and F. B. Laney. Idaho Bur. Mines and Geol. Bull. 1, p. 100, 1920.

Some beautiful little specimens showing radiating acicular prisms of malachite embedded in soft limonite have been obtained from the Horst-Powell (Empire) and Handspike mines on the Little North Fork of Coeur d'Alene River. Specimens showing radial and small mammillary masses of malachite in limonite-silica skeletons and others having radiating green needles in cavities in quartz have been seen from the Hypotheek mine on French Gulch, 3 miles south of Kingston.

AZURITE (289)

Basic copper carbonate, $3CuO.2CO_2.H_2O$. Monoclinic.

The fine blue copper carbonate, azurite, occurs commonly with the related green carbonate malachite as stains, incrustations, and deep blue crystals where primary copper sulphides have been subjected to oxidation. The mineral is almost coextensive in distribution with malachite as the two are almost invariably formed together. Azurite is a little less common or abundant than malachite, however, since malachite is the more stable compound and azurite tends to change to malachite.

ADAMS COUNTY

In Adams County azurite is common as blue stains and incrustations in many of the copper mines of the Seven Devils district, but it is nowhere very abundant or in exceptionally fine specimens. As an ore mineral, it is fourth in importance in the oxidized ores.[77]

BLAINE COUNTY

Azurite has been found in small amounts in the Wood River region, where it forms from the oxidation of tetrahedrite and other copper-bearing primary minerals. In the Hamilton (Clyde) district azurite has been found in the Copper Bluff mine 1½ miles from the mouth of Basinger Canyon northeast of Clyde as thin blue crusts and stains with malachite along bedding planes in massive blue dolomite.[78]

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[77] D. C. Livingston and F. B. Laney. Idaho Bur. Mines and Geol. Bull. 1, p. 67, 1920.

[78] J. B. Umpleby. U. S. Geol. Survey, Prof. Paper 97, p. 113, 1917.

CUSTER COUNTY

Azurite accompanies malachite in the oxidized ores of the Alder Creek district. It is not an abundant mineral in the deposits, but is very generally present in the different stopes. Locally it is well crystallized in tabular crystals.[79] Elsewhere in the county this mineral appears in the oxidized portions of the veins, but is nowhere abundant enough to constitute an ore. In the Bayhorse district it occurs generally in small cavities in partly oxidized tetrahedrite ore. Minute crystals incrust tetrahedrite and chalcopyrite in specimens from the Bull of the Woods mine (Cat. No. 56518, U.S.N.M.) and thin coatings occur with malachite and bindheimite in partly oxidized galena-tetrahedrite ore from the Ramshorn mine (Cat. No. 51863, U.S.N.M.). A specimen from the No. 3 tunnel, Silver Bell mine, Bayhorse district, shows thin botryoidal coatings and drusy crusts and seams of azurite with oxidizing tetrahedrite. Small crystals in spongy limonite surrounding tetrahedrite in ore from the Skylark mine were measured and are illustrated in the drawing, Figure 71. These gave the following measurements:

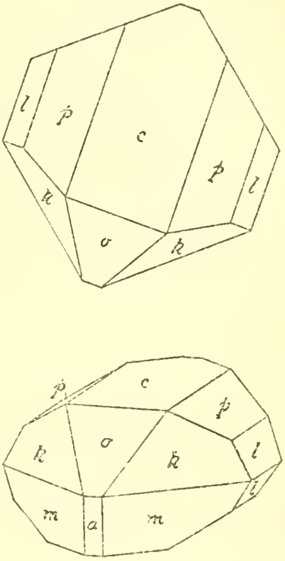

FIG. 71.—AZURITE. SKYLARK MINE, BAYHORSE DISTRICT, CUSTER COUNTY

Measurements of azurite crystal, Skylark mine

Form		Symbol		Quality, description	Measured				Calculated			
No.	Letter	Gdt.	Miller		φ		ρ		φ		ρ	
					°	′	°	′	°	′	°	′
1	*c*	0	001	Medium	90	00	1	57	90	00	2	24
2	*a*	∞0	100	do	90	00	90	00	90	00	90	00
3	*m*	∞	110	do	49	28	90	00	49	39	90	00
4	*σ*	10	101	Poor	90	00	46	39	90	00	47	10
5	*l*	0⅔	023	Very good	2	48	32	05	4	05	30	28
6	*p*	02	021	do	1	05	61	14	1	22	60	25
7	*h*	2	221	Excellent	49	38	70	13	50	13	70	02

ELMORE COUNTY

Small amounts of azurite have been reported as occurring in the ores of the Tahoma mine, Atlanta district.

LEMHI COUNTY

Although nowhere as abundant as malachite, azurite has been noted in most of the districts. It occurs in the oxidized portions of those veins which bear copper minerals.

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[79] J. B. Umpleby U .S .Geol. Survey ,Prof. Paper 97 ,p. 50, 1917

ONEIDA COUNTY

Azurite is reported to have been mined with other copper minerals at the Blackstone mine.

SHOSHONE COUNTY

Azurite has been found in moderate amounts in ores of the Horst-Powell (Empire), Handspike, and Riverside mines in the Little North Fork section. Some azurite has also been noted in oxidized lead ore in the Hypotheek mine south of Kingston. Similarly occasional specimens have been found in most of the lead mines, especially the Standard-Mammoth, Sierra-Nevada, and Caledonia. It was fairly common in the oxidized ores of the Caledonia mine, occurring usually as stains and impregnations in quartzite. Some specimens show crusts of fine deep blue drusy crystals and others show tabular crystals 5mm. in diameter. Some azurite has also been found in the Snowstorm mine and some of the other copper-bearing veins east of Mullan.

AURICHALCITE (290)

Basic zinc-copper carbonate, $2(Zn,Cu)CO_3.3(Zn,Cu)(OH)_2$. Monoclinic.

The basic double carbonate of zinc and copper, aurichalcite, has been seen from a single locality in Idaho, although it probably occurs elsewhere in oxidized zinc and copper-bearing ores.

CUSTER COUNTY

The specimen containing the aurichalcite is labeled as being typical ore from three sets above the 450-foot level of the Empire Copper Co.'s mine at Mackay. The aurichalcite occurs as a minutely bladed crust of pale delicate blue color, lining cavities in a dense greenish garnet rock which contains some fluorite. Under the microscope the aurichalcite is seen to form very thin plates which are transparent and pleochroic in tones of pale blue parallel to their elongation and colorless perpendicular to it. The mineral is biaxial, negative with small optical angle. Plates on edge are sky blue in color and have an extinction angle of 41°–42°. The indices of refraction are $\alpha = 1.660$, $\beta = 1.740$, $\gamma = 1.745$, $\gamma - \alpha = .085$. These optical properties indicate the identity of the material with aurichalcite. Minute blades of calamine are associated with the aurichalcite.

HYDROMAGNESITE (300)

Basic hydrous magnesium carbonate. $4MgO.3CO_2.4H_2O$. Monoclinic, earthy.

BANNOCK COUNTY

Hydromagnesite occurs as several deposits within 4 miles of Soda Springs in Bannock County. The mineral forms small disconnected surface deposits, one of which has a surface area of 13 acres, another of 8 acres, and a third of 2 acres. The hydromagnesite is from 2 to 4 feet thick, but below 2 feet the material is somewhat discolored.[80] A specimen of typical material from the locality, furnished by Mr. McDowell (Cat. No. 94140, U.S.N.M.) is white and earthy in texture and somewhat friable. It is very similar in appearance to many other white earthy materials and might be mistaken for chalk, clay, diatomaceous earth, or tripoli. It is not plastic when moist. Under the microscope the material appears mainly amorphous and isotropic with a refractive index of about 1.54, but it contains very numerous disseminated flakes of high birefringence which are too minute for their properties to be determined. The mineral could not be identified without chemical tests. An analysis of this material, made by the writer in the laboratory of the National Museum, gave the following results:

Analysis of hydromagnesite from Soda Springs

(E. V. Shannon, analyst)

	Per cent
Insoluble (silica)	7. 52
Alumina and ferric oxide (Al_2O_3, Fe_2O_3)	1. 77
Magnesia (MgO)	38. 28
Lime (CaO)	1. 18
Carbon dioxide (CO_2)	34. 97
Water (H_2O) above 105° C	15. 41
Water (H_2O) below 105° C	1. 06
Total	100. 19

From the nature and occurrence of this earthy hydromagnesite it would be expected to be impure. After deducting as impurities the silica, insoluble matter, lime, iron, alumina, and water below 105° C., the remaining constituents, recalculated to 100 per cent, are compared with the theoretical composition of hydromagnesite below.

	Original	Recalculated	Theory
	Per cent	*Per cent*	*Per cent*
MgO	38. 28	43. 18	43. 90
H_2O	15. 41	17. 38	19. 80
CO_2	34. 97	39. 44	36. 30
Total	88. 66	100. 00	100. 00

These figures show that the sample consists of approximately 90 per cent of hydromagnesite with 10 per cent of various impurities. These deposits may, in the future, have some commercial value for refractory materials or the other uses to which magnesite is put. The material is of a fair degree of purity and can be cheaply mined, but the additional water which it contains would probably make it more difficult and expensive to calcine than ordinary magnesite.

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[80] Information furnished by J. Spotts McDowell, of the Harbison-Walker Refractories Co. Personal letter, Nov. 13, 1920.

BISMUTITE (306)

BISMUTH OCHER

Basic bismuth carbonate, $Bi_2O_3.CO_2.H_2O$. Amorphous, earthy.

Bismutite or a related bismuth carbonate probably occurs at various places in Idaho as an alteration product of primary bismuth-bearing sulphides. The following occurrences have been noted.

BOISE COUNTY

Grains of a whitish mineral called "bismuth" are reported to occur commonly in placer concentrates from the Leary and Brogan placer tract one-half mile a little north of east of Placerville. A sample of this material consists of gray and lusterless grains having a suggestion of a fibrous structure or the columnar appearance of bismuthinite. A grain which was examined has a hardness of about 4, specific gravity 4.96. It is tough and tenacious and exhibits a waxy luster on fresh fracture. The mineral is soluble with effervescence in hot hydrochloric acid. Under the microscope it is very fine grained and crystalline with moderately high birefringence and very high refractive indices.

CUSTER COUNTY

Little cavities left by the oxidation of bismuthinite in rusty quartz specimens from the Empire mine, Washington Basin district, are partly filled with an earthy pulverulent dirty white hydrous bismuth carbonate.

KOOTENAI COUNTY

Small amounts of dirty white earthy bismuth carbonate occur in cavities in quartz from near the surface in the veins containing disseminated native bismuth in Carver and Varnam's Bismuth King property on Beauty Bay Creek near Beauty Bay, Lake Coeur d' Alene.

ORTHOCLASE

POTASH FELDSPAR

Potassium aluminum silicate, $K_2O. Al_2O_3. 6SiO_2$. Monoclinic.

Orthoclase is a common constituent of numerous igneous rocks, among them granite, granodiorite, monzonite, rhyolite, etc. In these rocks the orthoclase is commonly in relatively small grains and crystals and no specimens of these rocks in which the feldspar exhibits any especial interest have been seen from any Idaho locality. Only a few occurrences are mentioned. In granitic regions there are often found as rounded or lenticular segregations in the granite or dikelike or veinlike masses in either the granite or adjacent rocks, coarse aggregates of crystals of feldspar with quartz, mica, and sometimes other minerals, which are known as pegmatites or giant granites. Commercial mica and feldspar deposits are confined to such pegmatites. Pegmatites are of rather frequent occurrence in some parts of Idaho and are mined for mica in Latah County, although no commercially valuable feldspar deposits have as yet been opened. Such occurrences of orthoclase feldspar as have been noted are mentioned below. The variety of this mineral which is known as adularia of valencianite is considered separately.

ADAMS COUNTY.

Peculiar pegmatitic veins carrying flesh-red orthoclase associated with quartz, muscovite, and either chalcopyrite or bornite occur in the Lucky Strike (Walter James) and the Panama-Pacific (Victoria) claims in the Seven Devils Copper mining districts.[81]

BOISE COUNTY

Orthoclase occurs as a constituent of coarse pegmatitic spots and veins in the granite of Boise County especially near Shafer Creek and Idaho City.

KOOTENAI COUNTY

The quartz monzonite of the Chilco Mountain area is described by Calkins [82] as containing porphyritic orthoclase phenocrysts 1 inch long. A specimen of this rock from the Lieberg trail on the southwest side of Chilco Mountain several miles south of Lake Pend Orielle contains well-formed pinkish orthoclase phenocrysts up to 3 inches in maximum diameter.

LATAH COUNTY

Numerous pegmatites which are mined for mica near Avon contain coarse masses of orthoclase. Few specimens of this feldspar have been available for description and no data regarding it have been obtainable. Such specimens as have been seen are dirty white in color and present no unusual features.

LEMHI COUNTY

Orthoclase occurs in rounded crystals, carlsbad twins, and nearly spherical masses in granite or granite gneiss in the Blackbird district. These are approximately 3 inches in maximum diameter. They weather free from the rock and strew the ground like pebbles.

OWYHEE COUNTY

Orthoclase occurs as a constituent of pegmatites in the granite of the Silver City district.

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[81] D. C. Livingston and F. B. Laney. Idaho Bureau of Geology and Mines, Bull. 1, pp. 37-38, 1920.

[82] F. C. Calkins and D. F. MacDonald. U. S. Geol. Survey, Bull. 384, p. 44, 1909.

SHOSHONE COUNTY

Pegmatites consisting mainly of white or light colored feldspar, probably orthoclase, have been reported from the vicinity of Marble Creek in southern Shoshone County.

WASHINGTON COUNTY

Broad cleavages of fine fresh pink orthoclase have been examined. These were said to come from pegmatites on Council Mountain in Washington County. It is reported that a man in Boise was buying a limited quantity of this material at $5 a pound for use in a "secret chemical process." It is typical potash feldspar which is worth approximately $5 a ton on the eastern market.

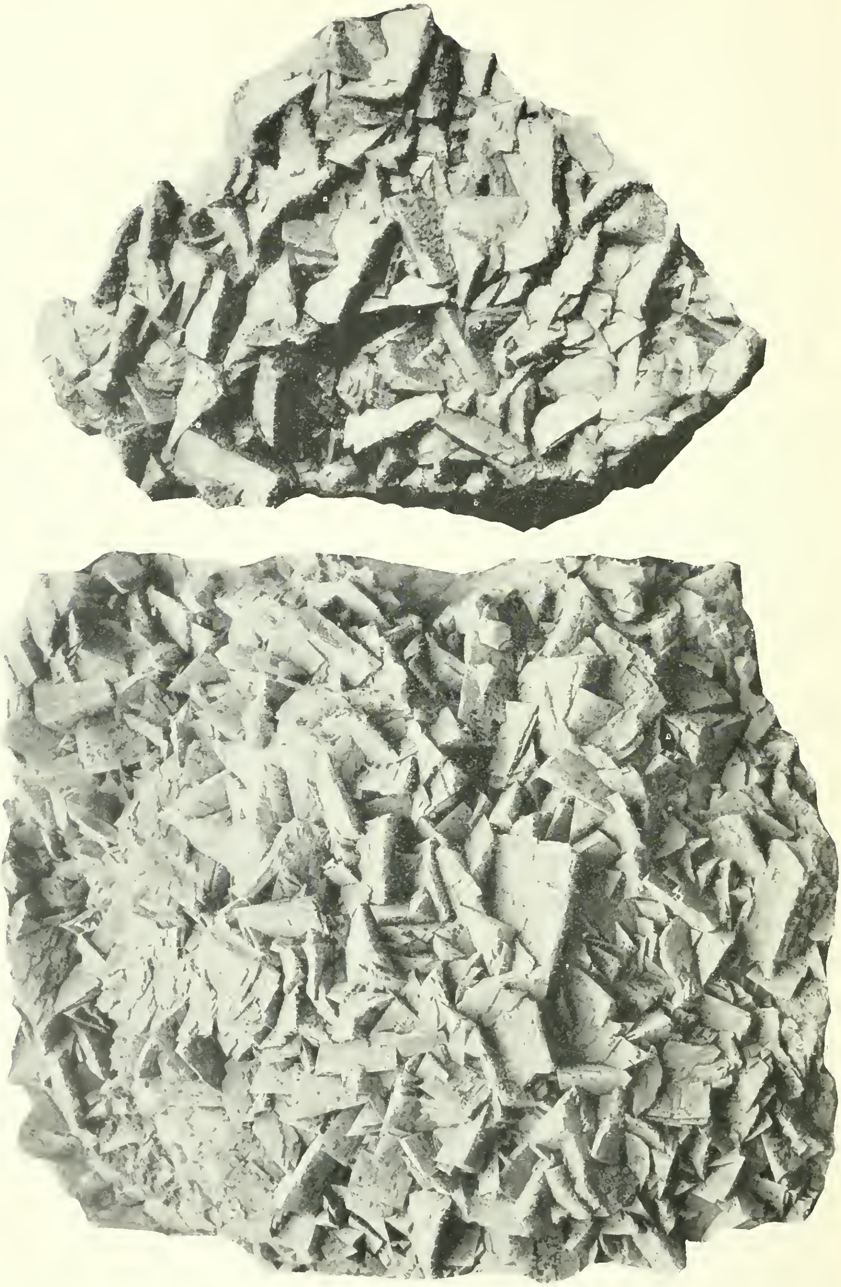
ORTHOCLASE, variety ADULARIA or VALENCIANITE

A form of orthoclasse occurring in white or colorless crystals probably deposited from solution rather than by crystallization from fusion has been called adularia and such orthoclase occurring as a vein mineral associated with silver ores has received the additional varietal name valencianite from the locality of Valenciana, in Guanjuato, Mexico. This was supposed to be distinct from orthoclase because the crystals differed, apparently, in angle. The occurrence of this unusual feldspar in Idaho was first noted by Lindgren in the silver mines of the Silver City district in Owyhee County, where it is abundant in fine large crystals, in several mines. It has since been noted by Umpleby in microscopic grains in similar precious-metal veins in Custer and Lemhi Counties.

CUSTER COUNTY

Valencianite (adularia) occurs in Custer County as a common though not abundant constituent of the gangue of the late Tertiary gold-silver veins. It is usually of microscopic size and occurs either intergrown with the quartz or included in it. These veins, which are confined to the Yankee Fork district, have been mined for gold and silver and are fissure veins inclosed in Miocene tuffs and lavas.

Adjacent to the veins the wall rocks are intensely altered, hydrothermally, by silicification or sericitization, or both, for a distance of 50 or 100 feet and in some cases 1,000 feet or more from the deposits. The silicification is most intense next to the veins and gives way to sericitization at a distance of 50 to 100 feet. The unaltered ore of the veins is a fine grained quartz, locally accompanied by a conspicuous amount of calcite and a little chalcedony, opal, and adularia. Of the metallic minerals pyrite alone is abundant and uniformly present. Tetrahedrite is not uncommon and chalcopyrite, galena, and, rarely, enargite occur. Widespread and important in the richer ores are blue-black submetallic bands and blotches in which pyrite,



ORTHOCLASE, VARIETY VALENCIANITE

FOR DESCRIPTION OF PLATE SEE PAGE 272

tetrahedrite, and rarely chalcopyrite may be recognized under the microscope, but the predominant material shows as blue-black specks too small to be identified. These all yield definite reactions for selenium. The calcite occurs in part as lamellar crystals, commonly replaced by quartz and much of the quartz has this lamellar form showing it to be pseudomorphous after calcite. The adularia is recognized in thin sections intergrown with or embedded in the quartz.[83]

LEMHI COUNTY

Adularia has been noted in the ores of the Gravel Range district. The veins here consist of fillings of fissures in rhyolite, the filling being principally crustified quartz in wavy bands parallel to the wall or concentrically arranged surrounding an inclusion or filling a former cavity. In the richer parts of the veins thin crimpy layers of dark color and dull to submetallic luster occur parallel to the crustification. These are rich in contained gold and silver and react for selenium. The quartz is hard and flinty and instead of having the usual vitreous luster tends to a dull white. Examined microscopically it is fine grained and occurs in bands composed of grains of slightly different sizes. Adularia, commonly occurring in beautiful rhombic microscopic crystals, is intergrown with the quartz or included in it.

The ore deposits of the Parker Mountain district are in every way similar to those of the Gravel Range district and, although adularia has not, as yet, been recognized in them it very probably occurs.[84]

OWYHEE COUNTY

Although the preceding occurrences of adularia in Idaho are of importance and interest, especially to the economic geologist, those of Owyhee County are more important to the mineralogist, since in the Silver City district in this county the mineral occurs as large crystals lining cavities in the veins which furnish fine specimens for collections. The mineral has been fully described by Lindgren,[85] who found it in the Booneville, Black Jack, and Trade Dollar mines, and the Cumberland vein on War Eagle Mountain. In the vein on which the Booneville, Black Jack, and Trade Dollar mines are opened, valencianite occurs as large milk-white grains with typical cleavage whether the vein is in rhyolite, granite, or basalt. The valencianite contains inclusions of chalcopyrite and argentite, sometimes with fillings of chalcopyrite in cleavage cracks. Crusts of projecting crystals of the valencianite, with more or less curved faces, often coat the walls of open spaces in the vein (pl. 6) and small clear crystals 1 to 3 mm. in diameter may also be found coating cracks and crevices in the granite adjoining the veins. In the Booneville mine small transparent crystals are found coating a lamellar quartz probably pseudomorphous after argentine clacite. All of these occurrences demonstrate the aqueous origin of the mineral. Prof. L. V. Pirsson examined the crystals and found them to have the habit of adularia with the forms (110), (001), and ($\bar{1}$01) as in crystals from St. Gothard in Switzerland. In the Idaho crystals, however, he found the base (001) usually very small and often wanting, the crystals then bounded only by (110) and ($\bar{1}$01) and having a strikingly rhombohedral aspect. This rhombohedral appearance is shown by the photographs of Plate 6 and the unwary mineralogist often pronounces the mineral calcite at a glance and specimens are found in collections labeled quartz pseudomorphous after dolomite, etc. The faces of the crystals examined by Pirsson were too uneven and striated to afford good material for measurement and the results served only to indentify the forms. The face ($\bar{1}$01) was strongly striated by oscillatory combination with the base. One of the larger crystals from Lindgrens illustrated specimen (pl. 6, lower) was analyzed by W. F. Hillebrand. The results of this analysis are below compared with the theoretical composition of orthoclase.

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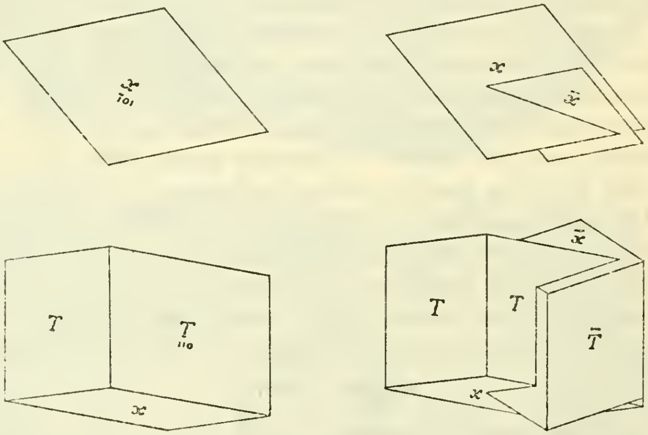
[83] J. B. Umpleby. U. S. Geological Survey, Bull. 539, pp. 46–47, 1913.

[84] J. B. Umpleby. U. S. Geol. Survey, Bull. 528, pp. 172–178, etc., 1913.

[85] Waldemar Lindgren. U. S. Geol. Survey, 20th Ann. Rept., pt. 3, pp. 166–168, etc., 1900.



72 73

Figs. 72–73.—72, Orthoclase (adularia). Crystal showing T (110) and x (101) simulating a rhombohedron. Silver City district, Owyhee County. 73, Same. Penetration twin on (100)

Analysis of valencianite, Silver City

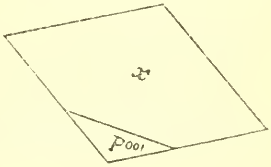
(W. F. Hillebrand, analyst)

	Per cent found	Per cent theory
Silica (SiO_2)	66.28	64.7
Alumina (Al_2O_3)	17.93	18.4
Potash (K_2O)	15.12	16.9
Soda (Na_2O)	.25	
Total	99.58	100.00

The specific gravity of the analyzed sample was found to be 2.54 (orthoclase = 2.57, Dana). A determination of alkalies in a specimen from the Trade Dollar vein gave George Steiger: Potash K_2O 14.95 per cent, Soda (Na_2O) 0.20 per cent. Another specimen from the same vein in basalt gave K_2O, 13.56 per cent.

In thin section the valencianite has the characteristics of orthoclase the index of refraction, a little lower than that of quartz, helping to distinguish it from that mineral. The crystals and grains are single individuals and many of the larger ones show optical anomalies probably due to pressure.

In addition to Lindgren's specimens, several collected more recently by E. L. Jones, jr., of the United States Geological Survey, have been examined. A specimen from the Blaine tunnel dump consists of a fine flat crust of white to colorless crystals of rhombic aspect reaching 7 mm. maximum diameter, coating a fissure in altered igneous rock. A specimen from a raise 1,300 feet from the portal of the Blaine tunnel consists of altered rock fragments cemented by a granular quartz-adularia aggregate containing finely disseminated silver sulphides and chalcopyrite. Drusy cavities in this specimen are lined with well-formed crystals of colorless adularia up to 5 mm. in diamater associated with small slender quartz crystals. A specimen from the ore bin of the Silver City mine consists largely of coarse granular white valencianite intergrown with quartz with small valencianite crystals of the usual habit in cavities. Another specimen from a tunnel dump on the south side of Long Gulch below the Blaine tunnel consists of fragments of altered and epidotized igneous rock cemented by quartz combs bearing curved and striated valencianite crystals up to 2 cm. in diameter. Some fluorite rests upon the valencianite.



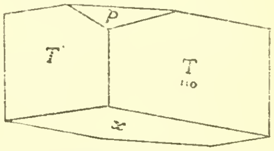


FIG. 74.—ORTHOCLASE (ADULARIA) SHOWING FACE OF P(001). SILVER CITY DISTRICT

The simple habit which characterizes the cystals from most of the specimens which show only the prism (110) and the negative dome ($\bar{1}01$) is illustrated in Figure 72, which brings out the strikingly rhombohedral aspect of the crystals. In Figure 73 is shown a twin on (100), the Carlsbad law. The crystal illustrated in Figure 74 shows also the base (001). The prism faces are greatly striated vertically and are always curved yielding poor measurements and ($\bar{1}01$) and (001) are striated horizontally by oscillation. A crystal of the habit shown in Figure 74, which showed also narrow line faces of (010) from the Blaine tunnel gave the following measurements:

Measurements of valencianite

Form		Symbol		Quality, description	Measured		Calculated	
No.	Letter	Gdt.	Miller		φ	ρ	φ	ρ
					° ′	° ′	° ′	° ′
1	*P*	0	001	Excellent	90 00	26 29	90 00	26 03
2	*X*	−10	$\bar{1}01$	Wavy	$\overline{90}$ 41	24 12	90 00	24 13
3	*M*	0∞	010	Very poor	0 55	90 00	0 00	90 00
4	*T*	∞	110	Very poor, rounded	59 32	90 00	59 23	90 00

MICROCLINE (315)

Potassium aluminium silicate, $K_2O.Al_2O_3.6SiO_2$. Triclinic.

The triclinic potash feldspar, microcline, is probably of frequent occurrence as a constituent of granitic igneous rocks in Idaho. Only the following occurrence has been especially mentioned.

SHOSHONE COUNTY

On Ninemile Creek, above the forks, where the railroad to the Success mine swings around the point of the hill and numerous cuttings are made in the southern syenite border of the Coeur d'Alene batholith, a part of the rock is strikingly porphyritic with numerous phenocrysts of feldspar in a matrix apparently consisting in the main of parallel needles of hornblende. The feldspar crystals are uniformly about an inch in length, are cream white to pinkish in color and many of them show carlsbad twinning. This feldspar has been found by F. C. Calkins to be microcline.[86]

ALBITE (316)

SODA FELDSPAR

Aluminium-sodium silicate, $Na_2O.Al_2O_3.6SiO_2$. Triclinic.

Like the other feldspars albite is probably much more widespread in occurrence in the state than existing records might seem to indicate. Only a single specific occurrence of mineralogic interest has been reported.

ADAMS COUNTY

At the Helena claim in the Seven Devils district intrusive granodiorite near its contact with limestone is rather intensely altered with the development of much zoisite. It has also suffered considerable sericitization and in many places contains open vugs or spaces lined with drusy well terminated colorless albite crystals.[87] It has not been possible to secure any specimens of this material for crystallographic study.

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[86] F. L. Ransome and F. C. Calkins. U. S. Geol. Survey, Prof. Paper 62, p. 49, 1908.

[87] D. C. Livingston and F. B. Laney. Idaho Bur. Mines and Geol., Bull. 1, pp. 64, 75–76, 1920.

ANDESINE (318)

SODA-LIME FELDSPAR

Sodium calcium aluminium silicate. Variable solid solution of albite ($NaAlSi_2O_8$) and anorthite ($CaAl_2Si_2O_8$) in proportions from Ab_3An_1 to Ab_1An_1. Triclinic.

Although andesine is of frequent occurrence as a rock making mineral, especially in the lavas of intermediate composition which are common in Idaho, the occurrences thus far described are of petrographic rather than mineralogic interest. The single occurrence described below is of this character, but furnishes material suitable for mineral specimens.

FREMONT COUNTY

The writer is indebted to H. T. Stearns, of the United States Geological Survey, for information on the interesting occurrence of andesine here described, as well as the occurrence of labradorite described below. The area is covered by a report in preparation by Mr. Stearns on the geology and water resources of the Mud Lake drainage basin, Idaho, to be published as a Water Supply Paper by the United States Geological Survey. The locality is Crystal Butte, about 18 miles north of St. Anthony and 8 miles southeast of Ivan. The rock is a lava, probably an andesite or basalt, which constitutes a fissure eruption with several cones, which Mr. Stearns regards as belonging to a period of igneous activity intermediate between the Tertiary andesites and the Snake River basalts. The rocks are made up of a dense black groundmass containing scattered large and well-formed phenocrysts of transparent plagioclase. These phenocrysts, weathered free from their matrix and strewing the surface of the cone, have given it the name Crystal Butte.

Most of the specimens examined are loose crystals. These reach a maximum diameter of about 7 cm. They are all tabular to (010), and some of them are twinned on the albite law. They are well bounded by crystal faces and are transparent, except where stained by infiltrated iron oxide or filled with fractures. In color they vary from colorless to pale yellow, and some small pieces are of gem quality.

A fragment from a typical crystal of this lot when examined optically proved to consist of calcic andesine. In powder under the microscope it is transparent and colorless; biaxial positive with 2E large, dispersion $r > v$ pronounced. No twinning lamellae were seen. The indices of refraction are $\alpha = 1.551$, $\beta = 1.555$, $\gamma = 1.558$. These indices identify the mineral as andesine of the composition $Ab_{55}An_{45}$.

Cleavage plates lying on 010 show the acute bisectrix, and yield an extinction angle of $Z' \wedge c = 15° \pm$.

LABRADORITE

LIME-SODA FELDSPAR

Sodium-calcium aluminium silicate, intermediate between albite ($NaAlSi_3O_8$) and anorthite ($CaAl_2Si_2O_8$), ranging in proportions from Ab_1An_1 to Ab_1An_3.	Triclinic.

Labradorite is a common feldspar in intermediate igneous rocks as diabases, basalts, and gabbros, and as a constituent of such rocks it is known from many localities in Idaho. The only occurrence noted which is of interest to the mineralogist is the following:

FREMONT COUNTY

The occurrence of andesine in the lava of Crystal Butte has been described above. A similar black porphyritic igneous rock makes up Mac's Butte in the same region, and a specimen from this Butte, also collected by Mr. Stearns, contains abundant pale yellow transparent tabular feldspars in a dense groundmass of streaked black and red lava. While the feldspars of the specimens average only about 5 mm. in length, an occasional crystal reaches a length of 2.5 cm. The largest are glassy, transparent, and pale yellow in color and show fine twinning lines to the eye. Under the microscope, in powder, the feldspar is colorless and transparent, and properly oriented grains show albite twinning lamellae. It is biaxial, positive with 2E large, dispersion pronounced, $r > v$. The indices of refraction measured are $\alpha = 1.560$, $\beta = 1.562$, $\gamma = 1.565$. These indices indicate the feldspar to be a sodic labradorite of about the composition $Ab_{40}An_{60}$ or Ab:An = 2:3. This feldspar is entirely similar in appearance to the andesine last described, and it is probable that study of a number of specimens from the same series of lavas would show a gradation of the plagioclases between these two examples.

THE PYROXENE GROUP

Of the relatively large number of minerals included in the pyroxene group only diopside, hedenbergite, and augite will be mentioned as occurring in Idaho. Probably others occur, but they have not as yet been given detailed mention in the literature nor have specimens showing features of interest been available for description. The most common pyroxenes in the State are those of the diopside-hedenbergite series. The end members of this series are:

Diopside	Calcium-magnesium pyroxene	$CaO.MgO.2SiO_2$
Hedenbergite	Calcium-iron pyroxene	$CaO.FeO.2SiO_2$

Every gradation between these two end members is possible, and isomorphous mixtures intermediate and near the 1:1 ratio are sometimes designated by the varietal name sahlite. Augite is similar to the diopside series, but differs in containing a notable amount of alumina. Members of the diopside-hedenbergite series commonly occur as metamorphic minerals, especially in limestone, while augite characteristically occurs as a rock making mineral on basic igneous rocks.

The approximate composition of a pyroxene of the diopside-hedenbergite series may be determined from its refractive index. The optical properties of the end members of the series are:

Diopside	$2V=59°$	$Z \wedge c=38\frac{1}{2}°$	$\beta=1.671$	Biref.$=0.030$
Hedenbergite	$2V=60°$	$Z \wedge c=48°$	$\beta=1.737$	Biref.$=.019$

In the absence of chemical data the minerals of the series may be allocated by the following approximate classification:

Diopside	β refractive index from 1.671 to 1.693.
Sahlite	β refractive index from 1.693 to 1.715.
Hedenbergite	β refractive index from 1.715 to 1.737.

Other less common members of the pyroxene group probably occur in Idaho, but in general little attention has heretofore been paid to the silicate minerals and few specimens have been collected for study.

DIOPSIDE

Calcium-magnesium silicate, Monoclinic.
$CaO.MgO.2SiO_2$.

The calcium-magnesium pyroxene, diopside, including members of the diopside-hedenbergite series in which magnesia is notably preponderant over iron, is by far the most common pyroxene in Idaho.

ADAMS COUNTY

Diopside is listed by Livingston and Laney [88] as a mineral common in the contact-metamorphic copper deposits of the Seven Devils district, and it has been noted in many specimens from this district by the writer. A specimen from the roadside near the lower tunnel of the Queen mine consists principally of granular green diopside, of the variety known as coccolite, with calcite, brown garnet, and disseminated grains of chalcopyrite.

BLAINE COUNTY

In the Hailey quadrangle diopside forms large rock masses. probably derived from dolomitic marbles, in the crystalline rocks forming the crest of the range. Such diopside rocks are well exposed in the cirques of the west side of Mount Hyndman at the head of

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[88] D C. Livingston and F. B. Laney. Idaho Bur. Mines and Geol., Bull. 1, p. 62, 1920

East Fork of Wood River. The diopside is coarse granular and varies from white to blue-gray in color.

Near the large granitic instrusion west of Hailey the limestones contain abundant white pyroxene, probably malacolite, with fibrous wollastonite.[89]

CUSTER COUNTY

In the Alder Creek district pyroxene, next after garnet, is the most abundant product of the metamorphism in the vicinity of the copper deposits. Diopside is the predominant constituent of the pyroxene rock formed from the limestone by metamorphism. During the earliest stages of the endomorphic alteration of the granite-porphyry the primary hornblende and biotite were altered to diopside. Finely disseminated diopside is scattered through much of the garnet rock and diopside, together with augite and hedenbergite, comprises bunches of pyroxene rock free from garnet. Such rock is dense, greenish, of aphanitic texture and has resinous to vitreous luster. In some thin sections of the massive pyroxene there occur a little plagioclase feldspar ($Ab_{65}An_{35}$) and chance grains of titanite, apatite, and fluorite. A specimen of typical diopside rock from near the second lateral, No. 3 crosscut, Alberta tunnel, analyzed by Chase Palmer, of the United States Geological Survey, gave the following results:[90]

Analysis of diopside rock from Mackay

(Chase Palmer, analyst)

	Per cent
Silica (SiO_2)	51. 55
Alumina (Al_2O_3)	4. 00
Ferric iron (Fe_2O_3)	1. 02
Ferrous iron (FeO)	6. 65
Magnesia (MgO)	11. 38
Lime (CaO)	24. 23
Soda (Na_2O)	. 38
Potash (K_2O)	. 18
Water (H_2O) below 110° C	. 14
Water (H_2O) above 110° C	. 25
Titanium oxide (TiO_2)	. 32
Carbon dioxide (CO_2)	. 00
Phosphoric acid (P_2O_5)	. 24
Manganous oxide (MnO)	. 30
Total	100. 64

The specific gravity of the analyzed material was 3.304. Assuming that the analysis represents essentially a single mineral, the first six constituents may be given, as the essential oxides, together with their ratios, as follows:

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[89] Waldemar Lindgren. U. S. Geol. Survey, 20th Ann. Rept., pt. 3, p. 195, 1900.

[90] J. B. Umpleby. U. S. Geol. Survey, Prof Paper 97, pp. 52, 58, etc., 1917.

	Per cent	Ratios		
SiO_2	51.55	0.860	0.860	0.860
Al_2O_3	4.00	.038	.045	.855
Fe_2O_3	1.02	.006		
FeO	6.65	.093	.810	
MgO	11.38	.285		
CaO	24.23	.432		
Total	98.83			

The ratio of ferrous iron to magnesia determines the position of the pyroxene in the diopside-hedenbergite series. The metasilicates of iron and magnesia are present in the above analysis in the molecular proportion of Fe:Mg=93:285 or 1:3.06, so that the material may be designated diopside.

A specimen of low-grade molybdenum ore sent to the National Museum from Challis consists almost entirely of granular green diopside containing flakes of molybdenite. Another specimen sent in by J. W. Copper from Hill City, Custer County, consists in the main of green diopsidic pyroxene.

In the Copper Basin district at the head of East Fork of Big Lost River diopside occurs abundantly in garnet-diopside zones in limestone, which are mined for copper.[91] A specimen from the Parallel tunnel of the Reed and Davidson mine in this district consists of granular diopside, containing magnetite and copper silicates, in considerable part altered to nontronite (chloropal).

In the Washington Basin district diopside occurs with the ore of the Empire ledge. In altered monzonite, in and adjacent to the vein, feldspar and biotite crystals are completely transformed to pyrrhotite and diopside. In the southern part of the vein pyrrhotite with about an equal amount or intermixed quartz and diopside forms a band 15 to 20 feet wide next to the hanging wall of the vein.[92]

LEMHI COUNTY

Diopside has been noted as colorless granular material associated with ludwigite in specimens from the Bruce Estate in the Texas district.[93] It is probably common in this property, which is a low-grade contact-metamorphic copper deposit in limestone.

OWYHEE COUNTY

Diopside occurs to some extent with other metamorphic minerals in lime-silicate zones in limestone mined in the Golconda and other mines in the South Mountain district. Specimens of lime-silicate rock from the road on Williams Creek 2 miles below the mines, South Mountain district, consist very largely of pale gray-green diopside in rough crystals up to 3 by 1 cm. in size. In powder under the microscope this pyroxene is transparent and colorless, is biaxial positive with 2V medium large; mean index, $\beta = 1.680$ and extinction $Z \wedge c = 36°–39°$.

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[91] J. B. Umpleby. U. S. Geol. Survey, Prof. Paper 97, pp. 104–105, 1917.

[92] J. B. Umpleby. U. S. Geol. Survey, Bull. 580, pp. 245–246, 1915.

[93] Earl V. Shannon. Proc. U. S. Nat. Museum, vol. 59, p. 667, 1921.

SHOSHONE COUNTY

No pyroxene has been noted in the ores of the Coeur d'Alene district, but a pale green to colorless species, probably diopside, is abundant in some of the contact metamorphosed sediments near the monzonite intrusions. It has been noted particularly in the Alameda tunnel near the Granite (Success) mine, where some originally calcareous bands in the sediments have been changed to aggregates of diopside, quartz, and green hornblende.[94]

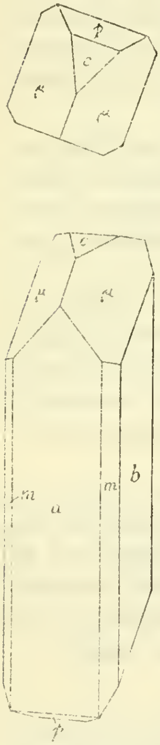

FIG. 75.—SAHLITE. STARLIGHT MINE, WARM SPRINGS DISTRICT, BLAINE COUNTY

SAHLITE

LIME-MAGNESIA-IRON PYROXENE

Calcium-iron-magnesium silicate intermediate between diopside and hedenbergite	Monoclinic.

In the absence of definite chemical or optical data it is not possible to definitely place the position of a pyroxene of this series and it is probable that some of those described above as diopside are in reality high enough in iron content to be designated by the varietal name sahlite.

BLAINE COUNTY

A specimen from the Starlight mine in Elkhorn Gulch near Ketchum in the Warm Springs district consists of a green mineral in prisms up to 5 mm. in length with interstitial calcite and considerable coarse granular brilliant black sphalerite intergrown with some pyrite. When the calcite is removed by solution in dilute acid the green mineral remains behind as lustrous prisms surrounded by spongy masses of minute crystals of lighter green color. The minute crystals are biaxial positive with 2V medium, extinction 46°, refractive index $\beta = 1.705 \pm 0.003$. The larger prisms are practically identical in optical properties with $\beta = 1.708$, so that the large and small crystals are both referable to sahlite. One of the larger crystals was measured and found to be pyroxene of normal habit. This crystal, which is illustrated in Figure 75, gave the following measurements:

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[94] F. L. Ransome and F. C. Calkins. U. S. Geol. Survey, Prof. Paper 62, p. 99, 1908

Measurments of sahlite, Figure 75

Form		Symbol		Quality, description	Measured				Calculated			
No.	Letter	Gdt.	Miller		φ		ρ		φ		ρ	
					°	′	°	′	°	′	°	′
1	*c*	0	001	Very poor, dim	90	00	16	12	90	00	15	51
2	*a*	∞0	100	Very good	90	00	90	00	90	00	90	00
3	*b*	0∞	010	Good	0	00	90	00	0	00	90	00
4	*m*	∞	110	Very poor, narrow	43	21	90	00	43	33	90	00
5	*p*	−10	101	Very poor, dim	90	00	13	47	90	00	15	27
6	*μ*	+12	121	Medium	35	43	54	40	35	36	55	24

A second specimen of similar material probably from the same or an adjoining locality is also made up largely of pyroxene with calcite, but contains more of the black granular sphalerite and a few brown dodecahedral garnets.

HEDENBERGITE

LIME-IRON PYROXENE

Calcium iron silicate, $CaO.FeO.2SiO_2$. Monoclinic.

Only a few localities are known in the State for the iron end member of the diopside series which seems to be decidedly rarer than the magnesian diopside.

ADAMS COUNTY

Hedenbergite is listed by Livingston and Laney[95] with a question (?) as occurring as a contact metamorphic mineral in the Seven Devils district.

CUSTER COUNTY

Hedenbergite has been noted in the Alder Creek district as a distinct mineral only in a few thin sections. Computation of analyses of the pyroxene shows that it enters into the diopside in solid solution in amounts ranging from 9 to 23 per cent.[96]

A specimen from the Basin prospect shows abundant hedenbergite as dull greenish to brown bladed fibrous masses mixed with galena. This prospect is located on the mountain north of Park Creek, which is the small stream occupying the low valley which connects the upper valley of Trail Creek with the headwaters of Lost River near where the Ketchum-Mackay road crosses the divide. Other specimens from the same tunnel contain epidote, garnet, prehnite, etc., in metamorphosed calcareous shale. Under the microscope the hedenbergite is opaque except in thin splinters, from the presence of an opaque brown pigment, probably limonite, due to its easy oxidation. Thin transparent splinters of the mineral appear colorless with no pleochroism. It is biaxial positive with a mean refractive index, β of 1.737. Sections of maximum extinction measure $Z \wedge c = 48°$. These properties indicate an iron pyroxene near the hedenbergite end of the series.

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[95] D. C. Livingston and F. B. Laney. Idaho Bur. Mines and Geol., Bull. 1, p. 62, 1920.

[96] J. B. Umpleby. U. S. Geol. Survey, Prof. Paper 97, p. 53, 64, 1917.

OWYHEE COUNTY

Hedenbergite occurs in contact-metamorphic deposits in limestone in the South Mountain district. It is the most abundant lime-silicate mineral in the Golconda mine where it is associated with ilvaite, calcite, sphalerite, chalcopyrite, etc. It ranges from a fine-grained massive rock to coarse masses of fibrous blades as much as 3 cm. long by 1 cm. thick. Some specimens from the Golconda dump are composed of finely fibrous silky-lustered rock of pale-green to brown color containing coarse calcite patches in which are embedded large crystals of ilvaite. The fine fibers tend to turn brown and oxidize rapidly with the formation of limonite, upon weathering. Examined under the microscope, this fine material is found to consist wholly of pyroxene dusted and stained with limonite. When the powdered mineral is treated with warm 1:1 hydrochloric acid the limonite is dissolved leaving the pyroxene better suited for optical examination. It is then pale-green, faintly colored, and nonpleochroic. Optically it is biaxial positive with 2V medium large, $r > v$ perceptible. The maximum extinction is approximately $Z \wedge c = 42°$. The refractive indices are, roughly, $\alpha = 1.715$, $\beta = 1.722$, $\gamma = 1.738$. The coarser varieties are optically identical. A medium coarse specimen of olive-green hedenbergite contains abundant chalcopyrite and one of the coarsest seen includes some coarse granular dark-colored sphalerite. The brownish olive-green color, fibrous appearance on cleavage surfaces, and especially the tendency to quickly weather brown upon exposure, readily identify this pyroxene.

AUGITE

ALUMINOUS PYROXENE

Variable silicate of lime, magnesia, ferrous and ferric iron and alumina. $CaO.MgO.2SiO_2$ with some $CaO.FeO.2SiO_2$ and $(Mg.Fe)O.(Al,Fe)_2O_3.SiO_2$. — Monoclinic.

Although augite is widespread in occurrence in Idaho as a pyroxenic constituent of igneous rocks, especially basalts, diabases, and andesites, no locality furnishing specimens of interest to the collector or mineralogist has yet been described in the State. In an area containing such quantities of eruptive rocks some localities will, in all probability, be discovered in which augite occurs in a basic igneous rock in phenocrysts of such size and quality as to make interesting mineralogical specimens.

WOLLASTONITE (320)

Calcium metasilicate, $CaO.SiO_2$. Monoclinic.

Wollastonite is a mineral which frequently develops in limestone by contact metamorphism adjacent to intrusive igneous masses. It is usually white in color with a more or less pearly luster and granular to fibrous structure. The granular varieties often resemble white marble and fibrous forms frequently simulate tremolite in appearance. The following localities have been noted in Idaho.

ADAMS COUNTY

Wollastonite has been listed with a question (?) by Livingston and Laney [97] as occurring in limestone with other metamorphic silicates in the contact copper deposits of the Seven Devils district.

BLAINE COUNTY

Specimens from the Starlight mine in Elkhorn Gulch near Ketchum, in the Warm Springs district, contain white fibrous wollastonite making up a lime-silicate rock with garnet and sahlite. Under the microscope the wollastonite is fibrous with prismatic cleavage parallel to the length, parallel extinction and rather high birefringence. It is biaxial negative with 2V medium, β about 1.628. The axial plane is across the fibers, so that the elongation is Y. Brilliant black sphalerite is intimately intergrown with the wollastonite, some of the prismatic grains of wollastonite being completely isolated in the sphalerite.

West of Hailey wollastonite occurs with diopside in metamorphosed limestone near the large granite instrusion.[98]

In the Drummond claim, on Little Wood River, Muldoon district, the ore occurs in a zone of contact metamorphism in which wollastonite and less garnet, diopside, and epidote have been developed in a calcareous rock.[99] A specimen from this mine consists of about equal parts of pale brown garnet and dense fibrous silky-lustered white wollastonite, which is fibrous, biaxial negative optically with 2V large and β refractive index $1.620 \pm .002$.

CUSTER COUNTY

A specimen from the Basin prospect north of the Trail Creek-Lost River Pass consists of pinkish fibrous sheets of wollastonite up to 4 mm. thick, in garnet-epidote rock. Under the microscope the wollastonite is biaxial and negative with 2V small. The fibers give parallel extinction with the optic axial plane across the length. The refractive index, β is 1.62. It is decomposed at boiling by 1:1 hydrochloric acid.

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[97] D. C. Livingston and F. B. Laney. Idaho Bur. Mines and Geol., Bull. 1, p. 62, 1920.

[98] Waldemar Lindgren. U. S. Geol. Survey, 20th. Ann. Rept., pt. 3, p. 195, 1900.

[99] J. B. Umpleby. U. S. Geol. Survey, Prof. Paper 97, p. 109, 1917.

In the contact-metamorphic copper deposits of the Alder Creek district wollastonite occurs as scattered small grains in much of the marble and garnet rock. Locally it forms a layer a foot or less in width between granite porphyry and limestone. On the side of the wollastonite away from the igneous rock is a persistent narrow layer of pale blue marble bordered by a silicified zone of blue limestone which grades outward through a foot or 18 inches into the unaltered rock. The wollastonite rock is white, granular, and massive, and resembles the marble.[1] A specimen of such wollastonite rock from the Case tunnel, Champion group, analyzed by W. C. Wheeler gave the following results.

Analysis of wollastonite rock, Mackay

(W. C. Wheeler, analyst)

Constituent	Per cent
Silica (SiO_2)	50. 47
Alumina (Al_2O_3)	. 45
Ferric oxide (Fe_2O_3)	. 16
Ferrous oxide (FeO)	. 10
Magnesia (MgO)	1. 17
Lime (CaO)	45. 99
Carbon dioxide (CO_2)	. 69
Total	99. 03

This analysis, computed in terms of mineral molecules gives the following:

Molecule	Per cent
Wollastonite	91. 24
Diopside	5. 61
Hedenbergite	. 23
Augite	. 89
Calcite	1. 75
Quartz	. 28
Total	100. 00

ANTHOPHYLLITE (337)

ASBESTUS

Magnesium silicate, $MgO.SiO_2$. Orthorhombic.

Anthophyllite occurs in one locality in Idaho in very large masses which constitute bodies of low grade "mass-fiber" asbestus similar to that which is mined at Sall Mountain, Ga. Several attempts have been made to mine this material. The mineral probably occurs in lesser amounts elsewhere in the State. Anthophyllite often contains more or less ferrous iron and thus graduates toward the similar orthorhombic iron amphibole described below under the name ferroanthophyllite.

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[1] J. B. Umpleby. U. S. Geol. Survey, Prof. Paper 97, pp. 55, 65, pl. 13, 1917.

ADAMS COUNTY

Anthophyllite is listed by Livingston and Laney[2] without further description, as a mineral of the contact metamorphis copper deposits in limestone in the Seven Devils district.

IDAHO COUNTY

Anthophyllite occurs in Idaho County 14 miles southeast of Kamiah in large masses similar to those of the asbestus mines of Sall Mountain, Ga. The mineral forms about half a dozen ledges within a few square miles. The largest of these ledges is lenticular in form and is 200 feet long, 40 feet wide and stands 30 feet above the ground. The lenses of anthophyllite apparently represent altered basic intrusions into the surrounding mica schist. Prospecting has revealed the bottom of some of them so they do not continue to great depth. Several of the masses are known and there are probably others as yet undiscovered, so that a great quantity of the material is available. The anthophyllite forms a mass-fiber asbestus, the fibers of which are arranged in small bundles 5 to 20 mm. in length and generally lying in all directions. Locally the fibers are arranged in radial groups which on cross-fractures yield rosettes sometimes 12 cm. in diameter. The fibers are brittle and as asbestus the material is poorer than the poorest chrysotile. The deposits were formerly worked by the Spokane Asbestus Fire Brick Co., who shipped the material to Spokane, where it was sawed into bricks or ground for various purposes.[2a]

A large specimen of the Kamiah asbestus was submitted for examination by Edward Sampson, of the United States Geological Survey. This consists of a group of rude prismoidal masses which resemble altered prismatic crystals of some mineral and are individually composed of parallel fibers of anthophyllite. These individual groups of fibers reach an extreme size of 10 by 10 cm. with an average of about 10 cm. in length by 3 cm. in thickness. The specimen is dirty white and somewhat iron-stained but, when fiberized, the fibers are fine, fairly flexible, and white. Selected and pure fibrous material from this specimen was analyzed with the following results:

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[2] D. C. Livingston and F. B. Laney. Idaho Bur. Mines and Geol., Bull. 1, p. 62, 1920.

[2a] J. S. Diller. U. S. Geol. Survey ,Mineral Resources of United States, 1909, pt. 2, p. 729.

Analysis of anthophyllite asbestus, Kamiah

(E. V. Shannon, analyst)

Constituent	Per cent
Silica (SiO_2)	57. 60
Alumina (Al_2O_3)	1. 94
Ferric oxide (Fe_2O_3)	1. 58
Ferrous oxide (FeO)	6. 62
Lime (CaO)	Trace
Magnesia (MgO)	30. 32
Water (H_2O) above 110° C	2. 66
Water (H_2O) below 110° C	. 20
Total	100. 92

This composition is essentially that of anthophyllite. Under the microscope the analyzed sample is in aggregates of exceedingly fine fibers which, in the aggregates, are apparently in parallel position and give a faint biaxial figure indicating the obtuse bisectrix perpendicular to the fibrous aggregate with the optic plane parallel to the length. These observations together with the fact that all of the fibers show parallel extinction with positive elongation indicate that the mineral is biaxial, positive with 2V large, orientation $Z=c$. The fibers are transparent and faintly brown. The refractive indices measured in the analyzed material are $\alpha=1.605$, $\gamma=1.625$, Birefringence$=0.020$. The optical properties of anthophyllite have been discussed by Bowen[3] who gives a diagram showing the increase in refractive indices with the increase of iron, stated as $FeSiO_3$. The total of both ferrous and ferric iron shown in the above analysis, calculated as $FeSiO_3$ gives approximately 15 per cent. The indices from Bowen's curves, for an anthophyllite of this composition, are $\alpha=1.613$, $\gamma=1.632$, appreciably higher than those found. If, however, only the ferrous iron be considered the indices derived from the curves are $\alpha=1.606$, $\gamma=1.624$, almost exactly those measured. This indicates that the ferric iron shown by the analysis is not essential, especially since it would be more influential than ferrous iron in increasing the indices. This supports the conclusion strongly suggested by the appearance of the specimen before grinding, that the ferric iron is extraneous and present as an infiltrated stain.

A number of specimens labeled Orofino, which were sent to the United States Geological Survey for examination by Dean Francis A. Thompson, of the Idaho School of Mines, are probably from the same area. The first of these consists of a mass of slightly curved splintery brittle fibers with silky luster, abutting against a mass of granular crushed white and green material. The silky fibrous material, under the microscope, contains two slightly different materials which are probably both anthophyllite. The first of these is coarse prismatic under the microscope and is transparent and colorless with good

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N. L. Bowen. Jour. Wash. Acad. Sci., vol. 10, p. 413, 1920.

prismatic cleavages. The extinction is parallel, the elongation positive, and the crystals tend to lie on a face giving medium low birefringence and showing the emergence of a negative bisectrix, probably obtuse but looking like an acute bisectrix with 2V large. The refractive indices are $\alpha = 1.612$, $\beta = 1.621$, $\gamma = 1.635$, birefringence $= 0.023$.

The second material associated with the preceding and apparently derived from it by alteration or shearing is made up of very fine fibers in matted aggregates having, in a section, a variable and non-pleochroic pale greenish-brown color and about the same birefringence as the other. The extinction is parallel and the elongation positive. The refractive indices are variable with $\alpha =$ about 1.595. The granular material of this specimen consists of glassy white to pinkish grains of the first mineral described above having scattered grains of actinolite which is identified by its green pleochroic color, negative optical character and extinction inclined about 17°.

The second specimen from the lot labeled as from Orofino consists of a large splintery fibrous mass 40 cm. in length and having a dirty white color. Under the microscope this is made up of coarse blades tending to split into minute fibers of positive elongation and parallel extinction. The indices of refraction are approximately $\alpha = 1.608$, $\gamma = 1.630$, birefringence 0.022.

Apparently all of the preceding are anthophyllites, varying in refractive indices probably with variation in iron and possibly water content. The finely fibrous forms are apparently secondary and derived by some mechanical process of weathering or shearing from a much coarser form of the same mineral. No indication of the source or origin of the anthophyllite is furnished by the specimens examined.

SHOSHONE COUNTY

The anthophyllite found by Ransome[4] in the Hercules mine is the high iron variety described below under the name ferroanthophyllite.

FERROANTHOPHYLLITE

Iron silicate, $FeO.SiO_2$. Orthorhombic.

The name ferroanthophyllite has been suggested for a member of the anthophyllite group in which the essential magnesia is wholly or largely replaced by ferrous iron.[5] Specimens from Idaho have been described in detail. Similar iron anthophyllite had previously been described from Massachusetts and several Scandinavian localities.

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[4] F. L. Ransome. U. S. Geol. Survey, Prof. Paper 62, p. 99, 1908.

[5] Earl V. Shannon. Description of ferroanthophyllite, an orthorhombic iron amphibole from Idaho with a note on the nomenclature of the anthophyllite group. Proc. U. S. Nat. Museum, vol. 59, pp. 397-401, 1921.

SHOSHONE COUNTY

The material described as ferroanthophyllite was collected in the Tamarack and Custer mine on Ninemile in the Coeur d'Alene district by Frank Barker who sent it to the United States National Museum for identification. The mineral contains galena and is stated to have occurred in the ore. While this mine is located no very great distance from the contact of an instrusive mass of quartz monzonite and several dikes of quartz-monzonite porphyry are reported to have been encountered in the mine workings, the inclosing rocks are unaltered quartzites in which metamorphic silicates in megascopically visible aggregates have not heretofore been reported. The occurrence of considerable amounts of this amphibole in the vein is therefore decidedly unusual. Inquiries and requests for additional specimens have been directed to both Mr. Barker and to the mining company but have not been answered.

The material as received consists of splintery-fibrous masses of a pale grayish-green color when dry and olive-green when moist. In all about 250 grams of the material were received in broken pieces. The individual fibrous masses reach a maximum length of 6 cm. The material separates easily into fine silky fibers which are moderately strong and flexible, being comparable to a poor quality of chrysotile, which the mineral resembles. The only associated mineral is a little fine granular galena which occurs interstitially between the fibers, as small nodules around which the fibers are curved or as fillings of small fractures in the mineral.

Under the microscope the mineral is in the form of very thin fibers which show positive elongation and parallel extinction. The indices of refraction determined are $\alpha = 1.668$, $\gamma = 1.685$, birefringence 0.017. Singly the fibers are colorless but thick aggregates of fibers are colored and pleochroic, X = pale brownish green, Z = deep brownish green.

An analysis made upon selected fibrous material gave the following results:

Analysis of ferroanthophyllite

(E. V. Shannon, analyst)

	Per cent.
Silica (SiO_2)	49. 30
Alumina (Al_2O_3)	1. 30
Ferric oxide (Fe_2O_3)	2. 15
Ferrous oxide (FeO)	30. 50
Manganous oxide (MnO)	3. 48
Lime (CaO)	10. 73
Magnesia (MgO)	. 66
Water (H_2O) above 110° C	2. 13
Water (H_2O) below 110° C	. 18
Total	100. 43

A single small specimen collected by Ransome[6] in the Hercules mine was described as containing a light gray silky asbestiform silicate crystallized with galena. Under the microscope the exceedingly fine fibers showed rather low double refraction and parallel extinction. The mineral, as tested by Dr. W. T. Schaller, was not attacked by acids and fused with difficulty. The original specimen collected by Ransome was examined by the writer. It consists of parallel aggregates of pale gray fibers up to 2 cm. long, intergrown with granular galena. It is colorless in thin section with positive elongation. The indices of refraction, which are $\alpha = 1.678$, $\gamma = 1.702$, birefringence 0.024, indicate this to be ferroanthophyllite, probably purer than that from the Tamarack mine.

TREMOLITE

Lime-magnesia silicate, $CaO.3MgO.SiO_2$. Monoclinic.

Tremolite is a comparatively iron-free amphibole occurring usually as white to grayish fibrous masses. It is often difficultly distinguishable from anthophyllite without an optical examination or an analysis. It is probably of common occurrence in metamorphosed limestone in Idaho but few specimens have been collected for study.

BLAINE COUNTY

A specimen labeled as from the face of the tunnel of the Red Elephant mine, Wood River region, consists of gray finely fibrous masses of tremolite containing small cubes of pyrite. Under the microscope the material is fibrous with prismatic cleavage and extinction slightly inclined to the elongation. It is biaxial, negative, with 2V medium large, refractive index $\beta = 1.623 \pm 0.003$. The country rock here is calcareous shale in which the tremolite is doubtless a mineral developed during metamorphism.[7]

CASSIA COUNTY

A specimen labeled "marble from marble quarry, Basin Idaho, T. 14 S., R. 22 E." consists of medium granular gray marble containing abundant gray blades and sheaves of tremolite up to 3 mm. thick by 15 mm. long. This mineral is colorless under the microscope and is biaxial negative with 2V large. The extinction is about 12°.

CUSTER COUNTY

Tremolite is comparatively rare in the contact-metamorphic copper deposits of the Alder Creek (Mackay) district, no good specimens having been reported. It occurs sparingly in the marble but is rare in the diopside rock.[8]

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[6] F. L. Ransome. U. S. Geol. Survey, Prof. Paper 62, p. 99, 1908.

[7] Waldemar Lindgren. U. S. Geol. Survey, 20th Ann. Rept., pt. 3, pp. 202–203, 1900.

[8] J. B. Umpleby. U. S. Geol. Survey, Prof. Paper 97, p. 55, 1917.

SHOSHONE COUNTY

A single peculiar occurrence of tremolite which has been determined in Shoshone County deserves record, although the material is not of specimen value. The specimens are labeled as from the dump of a shaft near the head of Big Creek and Silver Creek. They consist of quartz containing large rhombic molds from the removal of some rhombohedral carbonate, probably ankerite. These cavities are lined with a layer up to 3 mm. thick, of ocher-brown material with a faintly fibrous structure and silky luster. Under the microscope this is found to be a mixture of a bladed colorless mineral with fine limonite. In hot 1:1 hydrochloric acid the limonite is dissolved while the bladed mineral is undissolved. The optical properties of the blades are: Biaxial, negative, 2V medium large, extinction 15°–17°, $\beta = 1.623$. These optical properties identify the mineral as tremolite. This amphibole was probably included in the original carbonate which has been removed by weathering.

ACTINOLITE

Lime-magnesia-iron silicate, $CaO.3(Mg,Fe)O.4SiO_2$.	Monoclinic.

Actinolite differs from tremolite principally in containing more iron. It is usually in fibrous or acicular aggregates and is commonly deep green in color. The following occurrences have been noted in Idaho.

ADAMS COUNTY

Actinolite is listed by Livingston and Laney [9] as an abundant and widespread contact-metamorphic mineral in the Seven Devils region.

CUSTER COUNTY

Acicular actinolite occurs sparingly in the contact silicate rocks of the Alder Creek district. Its most common occurrence is as finely divided crystals in the white marble.[10] The mineral occurs also in veins up to 2 inches wide consisting of fibrous or acicular crystals in apparently unchanged blue limestone.[11]

IDAHO COUNTY

A small amount of green actinolite was noted in association with abundant anthophyllite in a specimen described above which was labeled as from Orofino, but which probably came from one of the Kamiah asbestus prospects.

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[9] D. C. Livingston and F. B. Laney. Idaho Bur. Mines and Geol., Bull. 1, p. 62, 1920.

[10] J. B. Umpleby. U. S. Geol. Survey, Prof. Paper 97, p. 49, 1917.

[11] J. F. Kemp and G. C. Gunther. Trans. Amer. Inst. Mining Eng., vol. 38, p. 269, 1908.

LEMHI COUNTY

Actinolite occurs in the Carmen Creek mine, Carmen Creek district. The ore occurs as lenses of quartz distributed through a band of schist. Much of the schist is mineralized with the development of pyrite, chalcopyrite, actinolite, and epidote. Much of the quartz contains magnetite, but the actinolite and epidote are confined to the inclusions of schist. The material is largely oxidized. The actinolite has the usual green color and radiate-fibrous structure.[12]

SHOSHONE COUNTY

Some very fine specimens of actinolite have been seen from the southern part of Shoshone County. The material came from some copper prospect, the location of which was vaguely described as in the St. Joe country. They consist of radiating olive green fibers up to 25 cm. long in pure masses up to 12 kilograms (25 pounds) in weight. Other specimens in the same lot consist of scaly masses of black biotite, large cubes of pyrite, and a very coarse rhombohedral carbonate, probably ankerite. The actinolite fibers inclose the pyrite crystals. The specimens were obtained by Harvey Ross, of Kellogg and Spokane.

HORNBLENDE (338)

VARIETY OF AMPHIBOLE

Variable silicate of lime, magnesia, and ferrous iron represented by the formula $CaO.3(Mg,Fe)O.4SiO_2$ with variable amounts of alumina and ferric iron probably entering as the compound $(Mg,Fe)O.(Al,Fe)_2O_3.SiO_2$.

Monoclinic.

While hornblende is of relatively common occurrence in Idaho as a rock constituent, only a few of the occurrences have received any special attention.

SHOSHONE COUNTY

In the southern part of Shoshone County, especially along the St. Joe-Clearwater divide, the rocks of the sedimentary Belt series of Algonkian age have been intensely metamorphosed, due in part to the nearness of the great Idaho batholith and in part to dynamic stresses acting under a heavy load of sediments.[13] Dikes and sills inclosed in the sedimentary rocks have in places suffered in the general metamorphism and have become schistose amphibolites in which the original pyroxene has changed to amphibole accompanied by the development of numerous garnets. Numerous metamorphic-minerals have developed in the sedimentary rocks, the most conspicuous being garnet, staurolite, cyanite, and hornblende. The hornblende is a common product of this metamorphism, especially in the calcareous rocks of the Wallace (Newland) formation. A specimen from west of the West Sister peak, Avery quadrangle (11–J–61 "hornblende" collected by E. L. Jones, jr., July 27, 1911), consists of black blades making up sheaves 2 cm. long by 1 cm. in maximum width. These sheaves are abundant in a cherty matrix which looks like limestone in the hand specimen but which contains no carbonate. Under the microscope the hornblende is very pale colored, though probably faintly pleochroic in tones of blue-gray and brown, but this is obscured by the presence of very abundant inclusions. It is biaxial negative (−) with 2V large. The extinction $Z \wedge c$ is 16° to 17°. The refractive index, β is about 1.629.

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[12] J. B. Umpleby. U. S. Geol. Survey, Bull. 528, p. 127, 1913.

[13] F. C. Calkins and E. L. Jones, jr. Geology of the St. Joe-Clearwater Region, Idaho, U. S. Geol. Survey, Bull. 530, pp. 75-86, 1913.

Another specimen of similar material from northwest of the Sisters (11–C–85 "amphibole rock" collected by Calkins, July 29, 1911, notebook No. 2, p. 5) consists very largely of sheaves and tufts of glistening black blades in a gray matrix which contains some carbonate. Under the microscope this hornblende is practically colorless, but is crowded with minute inclusions. The extinction, $Z \wedge c$ is 18° and the refractive index, β is 1.630.

A third specimen from the same general region (11–J–63 "Elevation 3,700 feet, in Creek, see traverse," collected by E. L. Jones, jr., July 27, 1911) is a somewhat waterworn mass from the stream bed. It consists of silky lustered greenish-black blades up to 1 cm. long by 5 mm. wide and 3 mm. thick, thickly disseminated in a scaly purplish base. The hornblende is biaxial negative with 2V large, dispersion $r<v$ weak; extinction $Z \wedge c$ is 11°–14°. It is pleochroic in pale colors, X = brownish-green, Y = greenish-brown, Z = bluish gray-green. The refractive indices are approximately $\alpha = 1.650$, $\beta = 1.660$, $\gamma = 1.669$. The purplish matrix of this hornblende consists of about equal parts of fine granular quartz and a pale brown uniaxial negative pleochroic micaceous mineral, doubtless biotite, and a few isotropic grains of colorless garnet.

HUDSONITE

VARIETY OF AMPHIBOLE

Silicate of ferrous iron with lime, alumina, ferric iron, etc. Monoclinic.

CUSTER COUNTY

A specimen, sent to the National Museum for identification by P. H. Rasche from Stanley, Custer County, consists mainly of an unusual amphibole having optical properties and composition approximating those of the varieties of amphibole which have been called hudsonite and hastingsite.

The specimen consists mainly of the amphibole which forms imperfect glistening black prisms up to 5 cm. in length by 2 cm. broad. These have very well defined cleavage. They are associated with a little diopside and calcite, and the appearance of the specimen suggests that it came from a crystalline limestone. Under the microscope the amphibole is very deep colored and is transparent only in thin splinters. It is biaxial and negative with 2V small; extinction $Z \wedge c = 23°–37°$; refractive indices $\alpha = 1.695$, $\beta = 1.702$, $\gamma = 1.712$; birefringence, $\gamma - \alpha = 0.017$. The pleochroism is intense, X = Greenish-brown, Y = Brownish-green, Z = Smoky blue-green. Absorption $Z > Y > X$.

A selected sample, purified by the use of heavy solutions and an electromagnet, was used for analysis. Microscopic study indicated the presence of 4 per cent of diopside in the analyzed sample. The results of the analysis are below compared with analyses of hudsonite and hastingsite.

Analyses of hudsonite and related low-magnesia amphiboles

Constituent	(1) Idaho	(2) Hudsonite	(3) Hastingsite
Silica (SiO_2)	38.50	36.86	34.18
Titanium oxide (TiO_2)	Trace.	1.04	1.53
Alumina (Al_2O_3)	10.88	12.10	11.52
Ferric iron (Fe_2O_3)	6.70	7.41	12.62
Ferrous iron (FeO)	27.28	23.35	21.98
Manganous oxide (MnO)	Trace.	.77	.63
Lime (CaO)	11.30	10.59	9.87
Magnesia (MgO)	1.40	1.90	1.35
Soda (Na_2O)	1.22	3.20	3.29
Potash (K_2O)	1.66	1.20	2.29
Water (H_2O) above 110° C	1.27	.60	.35
Water (H_2O) below 110° C	None.	.70	----------
Total	100.21	99.72	99.61

(1) Amphibole from Custer County, Idaho. E. V. Shannon, analyst. Manganese and titanium were not estimated but were colorimetrically shown to be unimportant.
(2) Hudsonite, Cornwall, Orange County, N. Y. J. L. Nelson, analyst. S. Weidman, Am. Jour. Sci., vol. 15, p. 231, 1903.
(3) Hastingsite, Dugannon, Ontario. Adams and Harrington, Amer. Jour. Sci., vol. 1, p. 213, 1896.

The Idaho material is nearer hudsonite in composition and hence may be designated by this varietal name until the character and relationships of these minerals are satisfactorily interpreted.

BERYL (344)

Beryllium-aluminium silicate, $3BeO.Al_2O_3.6SiO_2$. Hexagonal.

Only two occurrences of beryl have thus far been reported from Idaho.

LATAH COUNTY

Beryl is found in the pegmatites of the mica mines near Avon associated with feldspar, quartz, mica, etc. The mineral has been especially mentioned from the Levi Anderson and Muscovite mines,[14] and probably occurs in others. Specimens from this locality show prismatic crystals up to 5 cm. in diameter and 15 cm. long. These have fairly smooth prismatic planes but the terminations are incomplete. In color they are all pale yellow-green and they vary from translucent to transparent. Some small fragments might be cut into pale colored gems. Often the crystals are greatly fractured and many of them are iron stained.

NEZ PERCE COUNTY

Ernest Schernikow of New York has reported the finding of two good blue beryl crystals near Lewiston. These were obtained from an Indian squaw who would not reveal their source.[15]

THE GARNET GROUP

The garnet includes a number of well-defined minerals crystallizing in the isometric system and having the general formula:

$$3R''O.R'''_2O_3.3SiO_2$$

These vary by replacement of both the bivalent and trivalent oxides, thus $R''O$ may be FeO, CaO, MgO, or MnO and R'''_2O_3 may be Al_2O_3, Fe_2O_3, or Cr_2O_3. The end members of the group which are important in Idaho occurrences are:

Almandite	$3FeO.Al_2O_3.3SiO_2$
Spessartite	$3MnO.Al_2O_3.3SiO_2$
Grossularite	$3CaO.Al_2O_3.3SiO_2$
Andradite	$3CaO.Fe_2O_3.3SiO_2$

The magnesium garnet, which has not thus far been demonstrated to be the major constituent of any Idaho garnet, has the formula:

Pyrope	$3MgO.Al_2O_3.3SiO_2$

Members of the group containing titanium, chromium, etc., are known but have not been reported from this State. While the ultimate classification of any garnet demands an analysis, it is possible, granting certain assumptions, to classify garnets for the purpose of description here by their general properties and mode of occurrence. There seem to be limits to the miscibility of the several members. From available data it seems that, so far as Idaho garnets are concerned (1) to pink to red or purplish garnets in pegmatite are variable isomorphous mixtures of almandite and spessartite; (2) red to brownish red garnets in schists and slates are principally almandite. While these are usually very largely almandite it is rare that one of them approaches the maximum refractive index of pure almandite, 1.830, since they usually contain small amounts of pyrope and spessartite which lower the index to below 1.820. The brown-red garnets grade into the last group by increase in manganese and they can not be separated from them either on the basis of color or refractive index. Some distinctly brown-red examples react strongly for manganese; (3) the brown to greenish or sometimes nearly colorless garnets occurring as the products of contact metamorphism at the contacts of limestone with granitic intrusives are variable mixtures of grossularite and andradite. In this group the composition may be judged with some certainty by the refractive index.

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[14] Douglas B. Sterrett. Mica deposits of the United States, U. S. Geol. Survey Bull. 740, pp. 89–93, 1923.

[15] U. S. Geol. Survey. Mineral Resources of United States for 1907, p. 799.

ALMANDITE-SPESSARITE SERIES

All of the distinctly red garnets of the slaty and schistose rocks and the purplish to rose-red garnets from the pegmatites may be classified as almandite, since they doubtless contain a preponderance of the almandite molecule. The pegmatite garnets having the rose-red color are probably largely free from pyrope and consist of more or less pure isomorphous mixtures of the almandite and spessartite molecules. Thus their composition can be estimated from their refractive index as follows:

Almandite	Rrefractive index between 1.820 and 1.830
Almandite-spessartite	Refractive index between 1.810 and 1.820
Spessartite	Rrefractive index between 1.800 and 1.810

This relationship may be completely confused by the entry of a little of the low index pyrope molecule into the mineral. The classification by color is fairly reliable, most but not all of the notably manganiferous garnets having the rose tint. The color is, however, the only basis for classification of the loose grains and pebbles found in placers, in the absence of a chemical analysis. It has, of course, been impossible to note all of the occurrences of red garnet known in the State, especially in the heavy residues from placer sands, and only a few of the more important can be mentioned here.

ADAMS COUNTY

Almandite is mentioned from the Peacock claim by Palache,[16] but it is believed that the mineral was identified by color and specimens conforming to the description given, although red brown in color and superficially resembling almandite were found to be almost free from ferrous iron and to be andradite. Palache's description is accordingly given under andradite.

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[16] C. Palache. Amer. Journ. Sci., vol. 8, p. 300, 1899.

BOISE COUNTY

In Boise County and many of the adjacent counties the heavy residues from placer gold washing operations contain abundant garnet ranging from fine sand to rounded pebbles the size of a walnut. These are deep red in color and many of them are of gem quality. All of these are brownish-red in color, no distinctly rose red ones having been seen. A specimen of coarse concentrate from Centerville contains numerous such garnets. One bright red trapezohedral crystal 4 mm. in diameter has an index of refraction between 1.80 and 1.82 as has a brownish red irregular fragment from the same lot. A bright brownish-red trapezohedral crystal had an index very close to 1.815. A lot of 50 small garnets uniformly 1 mm. in diameter were crushed and examined. These came from a concentrate from the Boston-Idaho dredge, Idaho City. The color was brownish red. The garnet of this lot is colorless in section, isotropic, and varies in refractive index from 1.810 to 1.815.

BINGHAM COUNTY

A sample of heavy concentrate from fine Snake River sand from a placer mine at Rosa, Bingham County, contains occasional grains of brown-red garnet.

CAMAS COUNTY

A sample of placer concentrate from Bear Creek, Camas County, contains common minute sharp crystals of brown-red garnet.

CLEARWATER COUNTY

Red garnet, mainly of the purplish shade indicative of a notable content of spessartite, occurs commonly in the heavy residues from gravels worked for gold, in various localities in Clearwater County. A sample labeled as from Cow Creek, Pierce district, contains fairly large grains and crystals, all of which have a purplish or rose-red color. One trapezohedral crystal from this lot of purplish-red color, 3 mm. in diameter, has a refractive index of 1.807. Another irregular fragment of about the same size and color has an index of 1.815. All the garnet of this sample is about the same in color and refractive index.

A sample of coarse garnet in the Museum collection (Cat. No. 87508, U.S.N.M.) from Clearwater County consists of a large number of pieces of various colors. A number of these were examined. The colors are either brown red to reddish brown and black, or rose-red to purplish red. A rough black trapezohedron 2 cm. in diameter gave a brownish powder when ground in a mortar. Under the microscope the grains were colorless, transparent, and isotropic, but there is a sprinkling of brown iron-stained material, indicating that the color observed in the hand specimen is due to staining. The index of refraction of the garnet is 1.815. A clear transparent brownish-red irregular fragment from this lot has an index of 1.813. A clear brown-red trapezohedral crystal 5 mm. in diameter gives purplish fragments with brown stained grains. The index is 1.815. A clear transparent brownish-red flake has an index of 1.815 while a clear purplish-red fragment of the same size has an index of 1.804. A fine transparent brown-red piece 1 cm. in diameter has an index of 1.807 and upon testing gave a strong manganese reaction. A black well-formed trapezohedral crystal 7 mm. in diameter, opaque in the specimen, when crushed was found to be stained along cracks and the garnet was colorless except in the thickest pieces, which were rose red. This has an index of 1.818. It is thus evident that, in this lot at least, the color of the garnet is of no value in classification nor can the spessartite-bearing garnets be determined by their refractive index.

Placer concentrates from the Rich Hill Mining Co. and others marked Rhodes Creek contain purplish-red garnet.

ELMORE COUNTY

Purplish-red garnet is abundant in sand concentrates from the Big Rock placer claim, Wood Creek, Elmore County.

IDAHO COUNTY

Placer concentrates from the various localities in the Elk City district contain moderate amounts of garnet, mainly brown-red in color.

LATAH COUNTY

Pink garnets are of frequent occurrence in the pegmatites which are mined for mica near Avon in Latah County. A specimen from the Luella mica mine has been examined in detail.[17] This specimen, which was collected by Dean Francis A. Thompson, of Idaho School of Mines, is stated to be typical of the garnet occurring in the mica-bearing pegmatite of that area. The pegmatite consists of coarse crystals of muscovite, quartz, feldspar, and abundant black tourmaline in addition to the garnet. The garnet is purplish rose-red in color and is much traversed by cracks which render it friable, granular, and somewhat opaque. It forms grains or imperfect trapezohedral crystals up to 1 cm. in diameter embedded in quartz or in mica, the most perfect crystals being those which are surrounded by muscovite. There is no flattening of the garnet crystals between the laminae of mica.

A sample carefully selected and purified by the use of an electromagnet and heavy solutions was analyzed yielding the results and ratios below:

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[17] Earl V. Shannon. Note on garnet from a pegmatite in Idaho. American Mineralogist, vol. 7, pp. 171–172, 1922.

Analysis and ratios of garnet from Avon

(E. V. Shannon, analyst)

Constituent	Per cent	Ratios		
Silica (SiO_2)	35.84	0.594	0.594	1.00×3
Alumina (Al_2O_3)	21.20	.207	.209	1.06×1
Ferric iron (Fe_2O_3)	.28	.002		
Lime (CaO)	Trace.	-----	.615	1.04×3
Ferrous iron (FeO)	27.84	.388		
Manganous oxide (MnO)	14.33	.202		
Magnesia (MgO)	1.04	.026		
Total	100.53			

These ratios yield the garnet formula, $3RO.R_2O_3.3SiO_2$. The small amount of ferric iron can not be present as the andradite molecule ($Ca_3Fe_2(SiO_4)_3$) which is the only recognized garnet molecule containing iron in the trivalent State, as the amount of lime required (0.29 per cent) does not occur in the mineral. Grouping the ferric iron with the alumina in the almandite molecule the garnet has the following molecular and percentage compositions:

	Molecular ratio	Weight per cent
Almandite	1,292	63.61
Spessartite	673	32.95
Pyrope	86	3.44
Total	2,051	100.00

The measured index of refraction of the analyzed powder is 1.818 while the calculated value for a garnet of the above composition, based upon Ford's data for the end members of the group, is 1.816, the two agreeing within the limit of error.

LEMHI COUNTY

Garnet occurs at several places in Lemhi County in schists. The crystals sometimes reach 2 cm. in diameter. The garnet is apparently almandite.

MINIDOKA COUNTY

Small grains of both brownish-red and purplish-red garnet are frequently observed from placer concentrates from Minidoka and elsewhere in Minidoka County along Snake River.[18]

NEZ PERCE COUNTY

Numerous grains of garnet both of rose-red and brown-red color have been noted in a placer concentrate from the Early Bird placer on Clearwater River near Lewiston. Fine purple almandine garnets of gem quality have been reported to occur in quantity in placers near Lewiston.[19] Garnets resembling spessartite and showing rounded crystal faces were sent to Salt Lake for cutting from a locality near Orofino in 1915.[20]

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[18] Earl V. Shannon. Mineralogy of some black sands from Idaho, Proc. U. S. Nat. Museum, vol. 60, art. 3, 1921.

OWYHEE COUNTY

A specimen of pegmatite from the Silver City mine, Silver City district, contains scattered small purplish red trapezohedral garnets in a coarse aggregate of mica and feldspar. These crystals are sharp and perfect and average 3 mm. in diameter. They have an index of refraction of 1.812.

SHOSHONE COUNTY

Small crystals of reddish garnet are fairly abundant in the contact-metamorphic zones that surround the intrusive mass of monzonite north of Canyon Creek in the Coeur d'Alene district. The mineral occurs also as a gangue constituent intergrown with metallic sulphides and magnetite in ore deposits within the metamorphic zones particularly the Helena-Frisco, Custer (Tamarack), Granite (Success) and Sixteen-to-one (Rex) mines. In the last two properties some of the crystals are large enough to be recognized by the naked eye but for the most part the mineral is microscopic. In the Granite (success) mine, for example, a pink tint which is characteristic of the quartzite close to an orebody is seen in thin section to be due to the presence of numerous microscopic garnets.[21]

South of the Coeur d'Alene district, in the Avery quadrangle, especially along the St. Joe-Clearwater divide, garnet is extensively developed in the metamorphosed Belt sediments where they approach the central Idaho batholith. A number of specimens collected in this area by F. C. Calkins and E. L. Jones, jr., of the United States Geological Survey have been examined. A specimen labeled "garnetiferous quartzite" from Lookout Mountain, Avery quadrangle, consists of sandy dirty white quartzite having micaceous parallel parting planes from 5 mm. to 1 cm. apart. Rusty brownish red garnets up to 3 mm. in diameter occur along these partings (10–C–36). Three specimens labeled staurolite schist (11–C–129, 130, 131) from near bench mark 6225, Avery quadrangle (Bathtub Mountain(?)) are similar to each other. These consist of fine grained mica schist containing abundant small garnets and staurolite crystals 5 mm. long, some of them cruciform, and a few large coarsely granular mica pseudomorphs, probably after cyanite. The garnets are flattened parallel to the schistosity. They average 1–2 mm. in diameter and are purplish rose pink in color. The index of the garnet of one specimen is 1.810 and of another 1.812.

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[19] U. S. Geol. Survey, Mineral Resources for 1892, p. 768.

[20] U. S. Geol. Survey, Mineral Resources for 1915, pt. 2, p. 851.

[21] F. L. Ransome and F. C. Calkins. U. S. Geol. Survey, Prof. Paper 62, p. 99, 1908.

A specimen of garnetiferous mica schist from "head of gulch east of Prospect Knob" contains brownish red garnets, somewhat iron stained, up to 1 cm. in diameter.

One of the largest of the garnet crystals seen from this area is dodecahedral in form and is 7 cm. in diameter. It is greatly fractured and the fractures are partly filled with manganese oxide. After the manganese oxide is dissolved the garnet is purplish pink in color. It reacts strongly for manganese. The refractive index is 1.805. The exact locality or mode of occurrence of this specimen (11–J–84) was not learned. A specimen containing numerous garnets up to 8 cm. in diameter (10–L–64B) shows a central feldspathic streak, probably pegmatite, bordered by the coarse garnets associated with black biotite. The garnet may owe its origin to the pegmatitic material. The only locality given for the latter specimen is "Clearwater Basin."

ANDRADITE-GROSSULARITE SERIES

Brown to green garnets occurring as contact metamorphic minerals in limestone silicate zones adjacent to igneous intrusions range in composition from grossularite, the lime-alumina garnet, to andradite, the lime-ferric iron garnet. Admixture of other garnet molecules is so rare in this situation as to be negligible. Every gradation exists between these two end members and, owing to the large range in refractive index covered by the isomorphous series it is possible to estimate accurately the composition of a given garnet from its refractive index. They may be roughly classified by the following scheme.

Andradite	refractive index from 1.842 to 1.895
Andradite-grossularite	refractive index from 1.788 to 1.842
Grossularite	refractive index from 1.735 to 1.788

Garnets of this series are known to occur in a number of places in Idaho, some of which furnish fine mineral specimens. The lime garnets have an economic importance because of their frequent association with valuable ores.

ADAMS COUNTY

Lime silicate garnets are abundant in many places in the Seven Devils and adjacent districts making up silicate contact zones in limestone which are mined for copper. The garnet is present as well-formed crystals and the locality is capable of furnishing cabinet specimens of garnet comparable to the best that have been found either in the United States or abroad. The garnet from this district was first described by Melville,[22] who mentions dark brown garnet as occurring throughout the Peacock mine in crystals exhibiting a combination of rhombic dodecahedron and trigonal trisoctahedron. A light-brown massive variety which was associated with bornite and powellite was analyzed with the following results:

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[22] W. H. Melville. Amer. Jour. Sci., vol. 41, p. 138, 1891.

Analysis of massive garnet from the Peacock mine

(W. H. Melville, analyst)

	Per cent
Silica (SiO_2)	38. 67
Alumina (Al_2O_3)	10. 08
Ferric oxide (Fe_2O_3)	16. 00
Ferrous oxide (FeO)	. 91
Lime (CaO)	33. 35
Magnesia (MgO)	. 77
Copper oxide (CuO)	Trace.
Ignition (H_2O)	. 06
Total	99. 84

Palache has studied garnet from this region and his descriptions are here reproduced.[23] Grossularite occurs at the White Monument mine in cinnamon-brown crystals showing only the trapezohedron (211) associated with a little epidote in an impure limestone. These often include layers of crystalline calcite, the exterior layer being garnet.

Andradite occurs in the Peacock mine in light to dark brown completely developed and very symmetrical crystals showing the forms (101), (211), and sometimes (321), embedded in glassy copper-stained quartz from which they easily separate, leaving beautifully sharp casts. A second type occurs in rough crystals an inch or less in diameter with dodecahedral form, edges slightly truncated by the icositetrahedron (211). The centers of these crystals are of a dark-brown garnet substance while the exteriors are uniformly coated with a shell of clear quartz ½ mm. thick conforming in minutest detail to the form of the garnet crystal. In thin section one of these shells formed a single crystal individual, apparently an original deposition controlled in its position by the garnet crystal. Outside the quartz is often a similar coating of iridescent epidote and at times thin plates of hematite lie between the quartz and epidote. Calcite has also formed similar layers in some crystals, and where removed it leaves them cavernous. The surfaces of garnet crystals coated with quartz and epidote are plane and look like pseudomorphs of these minerals after garnet.

Andradite crystals from the Copper Key mine are notable for the etching they have undergone. The forms originally present were (101) and (211) in almost equal development and perfectly symmetrical. The crystals have been rounded by deep corrosion (fig. 76) of all edges, the solvent action having been greatest at the ends of the trigonal axes where uneven faces have been produced. Shallow rounded grooves replace the edges between (101) and (211) and a rounding of the angles at the ends of the axes gives, in some cases, an approximation to a cubic face. The etch facets would give no measurable reflections, but their position shows that they are in part trisoctahedrons and in part hexoctahedrons. The faces of both (101) and (211) still retain a brilliant luster, but the former are marked by beautifully symmetrical and sharp etch pits of rhombohedral outline, their edges parallel to the dodecahedral edges of the crystal. The faces of (211) are grooved quite deeply parallel to the same edges.

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[23] Charles Palache. Amer. Journ. Sci., vol. 8, p. 300, 1899.

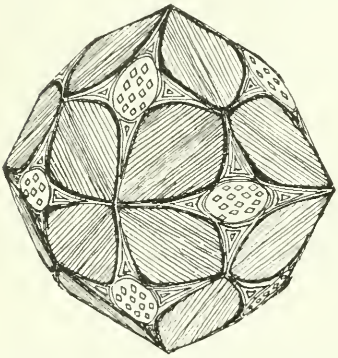

Fig. 76.—Garnet. Showing peculiar etching. Seven Devils district. After Palache.

The garnets sometimes reach large size. Livingston and Laney[24] found a portion of a well-formed crystal 18 cm. in diameter on the dump of the Arkansaw mine.

A number of specimens from this region which have been examined by the writer are described as follows:

A specimen from the Peacock claim consists of fine large dark-brown crystals up to 2 cm. in diameter embedded in quartz. These are dodecahedrons modified by narrow faces of the trapezohedron. They are associated with a little hematite and bornite. When broken out these crystals leave perfect molds in the quartz. Although firm and lustrous on the outside, these crystals, when broken, are found to be porous inside with the pores partly filled with chrysocolla. Under the microscope the garnet is transparent, isotropic, and devoid of notable zoning with an index of refraction above 1.82, estimated at 1.83. They are thus midway between grossularite and andradite in composition.

A specimen labeled "North drift, railroad tunnel," consists of dense massive, fine-grained pure garnet of brown color and greasy luster. It shows no suggestion of crystals, nor is there any other mineral than garnet visible in the hand specimen. Under the microscope the garnet is pale brown with a refractive index well above 1.82. It is isotropic. Numerous microscopic grains of calcite are included in the garnet.

Three specimens from the dump of the Queen mine consist of massive garnet containing large spots which are evidently large anhedral garnet crystals. These have cores up to 5 cm. maximum diameter of pitchy brownish-black garnet with pale greenish to grayish-brown outer layers. The outer layers grade into brown and cinnamon-brown material which abuts against vugs as fine little cinnamon-brown crystals up to 1 cm., across which are striated trapezohedrons with some small faces of the dodecahedron and other forms. The vugs contain later vivid-green columnar epidote, colorless quartz, and pale brown calcite. The inner pitch-black material has an index decidedly above 1.82—possibly 1.85 or higher—and is transparent grayish-brown and isotropic under the microscope. The outer grayish crust is porous, soft, and easily crushed in an agate mortar. Under the microscope it varies in index from a minimum of about 1.795 to near 1.820. Many of the grains show a notable birefringence, especially those having an index of refraction between 1.800 and 1.805. Some of these show a dividing plane like a twinning plane, probably a fragment of an original sector structure. Many yield sweeping extinction, but a few give uniform extinction and what appears to be a negative biaxial figure with large axial angle. The lustrous cinnamon-brown crystals show very fine laminated zoning parallel to the crystal faces and vary in index from about 1.803 to perhaps 1.835. The material is in part isotropic and in part feebly birefracting. One specimen from this locality is a large crystal 3 cm. in diameter, which is perfect in outer form, being a dodecahedron modified by faces of the trapezohedron. The outermost layer, which is rich brown-red, is 0.25 to 0.50 mm. in thickness and is easily peeled off, revealing a likewise perfect lustrous surface of greenish-gray color. Toward the center of the crystal the layers become thicker and less easily separable and alternate brown and grayish in color.

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[24] D. C. Livingston and F. B. Laney. Idaho Bur. Mines and Geol. Bull. 1, p. 63, 1920.

A specimen from the Arkansas dump consists largely of deep red-brown garnet containing only a little epidote which is apparently later than the garnet. The specimen is vuggy and against small cavities the garnet forms imperfect crystals of dodecahedral form up to 1 cm. in diameter. The powder is reddish buff. Under the microscope the grains are pale transparent brown and most of them show a feeble birefringence. The refractive index is decidedly above 1.82, estimated between 1.83 and 1.84. This garnet so resembles almandite in color that a determination of ferrous iron was made upon it which indicated a content of only 1.42 per cent FeO. A second specimen from the Arkansas dump consists of greasy grayish-brown masses and imperfect dodecahedral crystals averaging 1 cm. or less in diameter, scattered through coarsely crystalline white calcite, which also contains scattered fine-grained pale green masses of diopside. The garnet is apparently rather uniform in composition and yields a pale brown powder which is colorless in section with an index of 1.780. It is thus grossularite as contrasted with the red-brown andradite from the same mine.

The last specimen of this lot to be mentioned is from the Copper Boy mine. It consists mainly of reddish black crystals which are dodecahedrons modified by faces of the trapezohedron. These are brilliant in luster and of various sizes from 1 mm. to 2 cm. The black crystals are more porous and lighter colored inside. The outer layers are homogeneous and pale transparent brown, isotropic and have an index estimated at 1.825–1.830. They are laminated but not zoned parallel to the crystal faces. Another specimen from this mine contains brown granular garnet and some crystals up to 5 mm. in size showing the dodecahedron modified by broad faces of the trapezohedron. The garnet is interstitial to coarse columnar epidote. The granular garnet gives a brown powder in the agate mortar and under the microscope is seen to be a mixture containing the pale brown to colorless feebly birefracting garnet with an index above 1.82, mixed with quartz and what is probably partly oxidized hedenbergite.

While it is clear from the preceding descriptions that the garnet from the Seven Devils lime-contact deposits ranges from grossularite to andradite, the greater part of the garnet is well on the andradite side of the half-way composition.

BEAR LAKE COUNTY

Garnet occurs in Bear Lake County in NW. ¼, sec. 9, T. 8 S., R. 43 E. on Lane's creek, associated with hematite and calcite. The garnet is granular-massive and sugary textured, made up of minute imperfect dodecahedral crystals. The deposit is probably a metamorphosed limestone. Under the microscope the garnet is pale brown and isotropic with a refractive index moderately above 1.820. The calcite and hematite are described under the respective headings elsewhere in this report.

BLAINE COUNTY

Lime garnets intermediate between grossularite and andradite have been noted at several places in Blaine County.

A specimen from the Muldoon district labeled "Country rock," from the Drummond claim, is a chalky looking rock in part white and in part pale brown with a greasy luster. The very pale brown material is massive garnet without any trace of crystalline structure. Under the microscope it is colorless with an average index of refraction of 1.760, which indicates it to be grossularite. The garnet is filled with inclusions. The white material in the specimen is a fine-grained mixture of wollastonite and calcite.

Garnet occurs in the Starlight mine in Elkhorn Canyon near Ketchum as massive fine-granular brown garnet rock containing galena and also as small brown crystals associated with sahlite, etc. Another specimen from somewhere in this district consists of a large mass of greasy brown garnet, which, against included calcite, occurs as well-formed crystals.

CUSTER COUNTY

Lime garnet is known from numerous localities in Custer County. It is common in the Phi Kappa mine in Phi Kappa Canyon near the head of Big Lost River in granular massive grayish form containing galena, sphalerite, and chalcopyrite, probably developed in calcareous beds in Ordovician shale. Another specimen from a prospect in the same vicinity ("Prospect at 8560′ and N. 30 E. of high point on ridge across canyon") shows massive garnet rock and light-brown dodecahedral crystals up to 2 cm. in diameter with chalcopyrite, galena, sphalerite, and pyrite. Another specimen shows brownish granular massive garnet with galena. Specimens from the Basin group prospect which is a small tunnel at an elevation of 8,050 feet N. 24° E. of the top of the round knob 8,700 feet high just west of where the road from Ketchum to Mackay crosses the Trail Creek summit and across Park Creek contain abundant garnet. This is apparently a metamorphosed calcareous lens of shale which contains garnet in association with vesuvianite, epidote, prehnite, etc., and some sulphides. The garnet varies from gray to brown and some specimens show good brown crystals up to 7 mm. in diameter in calcite.

In the Copper Basin district at the head of east fork of Big Lost River garnet occurs abundantly associated with other lime silicates and magnetite as the gangue of copper ores in quartzite and calcareous shale or slate.[25] Specimens from the Reed and Davidson claims in this district consist of resinous brown granular masses of garnet rock made up of small crystals. A part of the garnet rock is porous and the cavities are lined with greenish-brown crystals which are dodecahedral in form, modified by faces of the trapezohedron.

In the Alder Creek district garnet is by far the most abundant mineral in the contact copper deposits about Mackay. The composition ranges from grossularite to andradite, while computation of analyses indicates the presence of very minor amounts of the almandite, spessartite, and pyrope molecules. The garnet occurs as euhedral crystals where embedded in calcite or along joints but elsewhere the individuals are anhedral owing to mutual interference. It locally includes cores of mixed magnetite calcite and quartz and concentrically distributed grains of chalcopyrite. Much of the garnet shows zones of anomalous birefringence under the microscope in thin section between crossed nicols, and the refractive index ranges from 1.82 to 1.84. The most characteristic form of garnet in this district is as a dense aphanitic rock of greasy to vitreous luster. In many places in the workings along the Alberta level this type of rock is continuous for scores of feet. In many thin sections nothing but garnet and a chance grain or patch of residual calcite appear.

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[25] J. B. Umpleby. U. S. Geol. Survey, Prof. Paper 97, p. 104, 1917.

Analyses of this massive garnet show the presence of from 35 to 45 per cent of the grossularite molecule. In all types of garnet in the deposits the andradite molecule is an important constituent. In the massive garnet it comprises about 50 per cent of the whole and in the dark amber-colored garnet which formed subsequently it is even more abundant. From the color of the garnet it seems possible as a rule to tell whether it is grossularite or andradite. Both of these varieties, however, as determined by index solutions, may be so nearly the same shade of amber color that no difference between them can be detected. The following table gives typical analyses of garnet from the ores of the Alder Creek district:

Analyses of garnet from Mackay

	(1)	(2)	(3)
Silica (SiO_2)	36.92	36.57	37.07
Alumina (Al_2O_3)	8.75	7.56	17.42
Ferric iron (Fe_2O_3)	16.85	20.34	10.81
Ferrous iron (FeO)	.50	1.24	.68
Magnesia (MgO)	.17	2.10	.51
Lime (CaO)	33.71	30.20	32.77
Soda (Na_2O)	.31		
Potash (K_2O)	.21		
Water (H_2O) above 110° C	.39	.54	.14
Water (H_2O) below 110° C	.21	.30	
Titanium oxide (TiO_2)	.26	.20	.39
Carbon dioxide (CO_2)	.95	.00	
Phosphoric acid (P_2O_5)	.30	.23	
Manganese oxide (MnO)	.67	.60	
Total	100.20	99.88	99.79
Specific gravity (lump)	3.647	3.664	3.63

(1) Massive garnet from 100 feet south of No. 5 crosscut, Alberta tunnel. Index of refraction 1.82–1.83. Maximum birefringence 0.01 ± 0.003. Chase Palmer analyst.[26]

(2) Dark amber-colored garnet crystals from 1.500 feet northwest of the Copper Bullion tunnel. Refractive index 1.840 ± 0.003. Chase Palmer, analyst.[26]

(3) Light amber-colored crystals. Cyril Knight, analyst.[26]

The garnet in the Mackay district is not confined to the limestone but large masses have developed endomorphically in the granite porphyry. Comparison of analyses of the garnet rock with those of the unaltered limestone indicates that great quantities of material were added, presumably by solutions emanating from the magma.[27]

A number of specimens of garnet from these deposits have been examined, although none of them have been studied in detail by the writer. A specimen from the mouth of the No. 8 crosscut,

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[26] J. F. Kemp and C. G. Gunther. Trans. Amer. Inst. Mining Eng., vol. 38, p. 286, 1908.

[27] J. B. Umpleby. U. S. Geol. Survey, Prof. Paper 97, p. 58, etc., 1917. The above notes on the garnet of the Alder Creek district are all abstracted from Umpleby's description.

Alberta tunnel, consists of very fine dense flinty brown massive garnet with waxy luster. A specimen from a fissure zone in No. 8 crosscut, Alberta tunnel, consists of pale olive green to yellow masses of garnet showing an occasional crystal face. Another from the second east drift, No. 300 level, Empire mine, is dense very fine-grained greenish garnet containing some disseminated fine grains of chalcopyrite and bornite. A typical specimen from the dump of the north tunnel is a very heavy dense fine-grained pale-greenish rock with greasy luster which is apparently pure garnet. A second specimen from the dump of this tunnel contains abundant small well-formed greenish yellow garnet crystals showing equal development of dodecahedron and trapezohedron, in fluorite. A third specimen, typical ore, from bins at the North tunnel contains vitreous brown grains and crystals of garnet in a matrix of chalcopyrite. Two specimens labeled "Copper bullion" show in one specimen small brown crystals and granules of garnet with magnetite and calcite in coarse white calcite, while the other specimen consists of yellow-brown porous masses of garnet with large imperfect magnetite crystals. Some fine little olive-green garnet crystals showing dodecahedron modified by trapezohedron abut against calcite filling cavities.

LEMHI COUNTY

A little garnet has been noted in association with forsterite in metamorphosed limestone on the Colorado group claims in the Spring Mountain district.[28] The Bruce Estate in the same district is said to have opened a copper-bearing contact zone in limestone which probably contains garnet, although no specimens of garnet rock have been seen from this mine.

FORSTERITE (375)

MAGNESIA OLIVINE

Magnesium silicate, $2MgO.SiO_2$. Orthorhombic.

Forsterite has been reported from 4 localities in Idaho, three of them contact-metamorphic products in limestone and the third an original constituent in an igneous rock.

ADAMS COUNTY

Forsterite has been listed with a question (?) as occurring as a contact mineral in the contact-metamorphic ore deposits of the Seven Devils district.[29]

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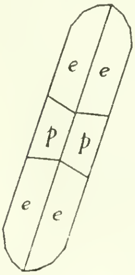
[28] J. B. Umpleby. U. S. Geol. Survey, Bull. 528, p. 88, 1913.

[29] D. C. Livingston and F. B. Laney. Idaho Bur. Mines and Geol. Bull. 1, p. 62, 1920.

BINGHAM COUNTY

Forsterite occurs as a constituent of nepheline basalt in Bingham County, 24 miles east of Blackfoot, which has been described in detail.[30] The forsterite is in clear grains of the usual form up to 2 mm. in diameter. The optical properties are biaxial negative, 2V (computed from the refractive indices) 87°; refractive indices $\alpha=1.641$, $\beta=1.661$, $\gamma=1.680$. In convergent light the bars of the interference figure are nearly straight and the dispersion of the optic axes is barely perceptible with $r>v$. In addition to embayments filled with the groundmass the forsterite carries a few inclusions of iron ore and chains of gas or liquid inclusions. The mineral shows no signs of alteration except for a narrow reddish border which probably represents incipient alteration to iddingsite. A Rosiwal determination on two thin sections showed 24.9 per cent by volume or 26.4 per cent by weight of olivine. The nepheline basalt carrying the forsterite is a rare rock. The rock forms a little knoll on a ridge that descends northeast along the north side of Wood Creek in the SW. ¼ of the SE. ¼ sec. 18, T. 3 S., R. 38 E. Boise meridian.



LEMHI COUNTY

Forsterite occurs as a contact-metamorphic mineral in two places in the Spring Mountain district in Lemhi County. In Dry Gulch on the Colorado group of claims where a quartz diorite dike invades the limestone the contact is cut by a tunnel which shows the metamorphic effect of the diorite intrusion. The metamorphically developed minerals include calcite, coarse flecks of muscovite and some biotite, all readily recognized megascopically. In addition pepperlike specks are scattered through much of the rock which, when examined microscopically, prove to be forsterite, the iron-free olivine, and a little garnet. Ore minerals do not occur associated with these contact minerals, but a vein a short distance up the hill contains argentiferous galena, manganese oxide, pyrite, and chalcopyrite in a siliceous gangue.[31]

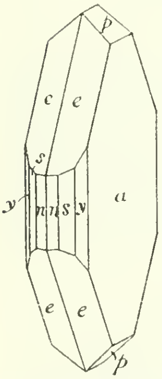


Fig. 77.—Forsterite. Bruce Estate, Lemhi County

The third locality for forsterite, and, to judge from the single specimen available, the most important mineralogically, is the Bruce Estate, which, according to Umpleby,[32] is a large low-grade contact-metamorphic copper deposit extending south from Dry Gulch in the Spring Mountain district. Ludwigite from this property is also described elsewhere in this volume.

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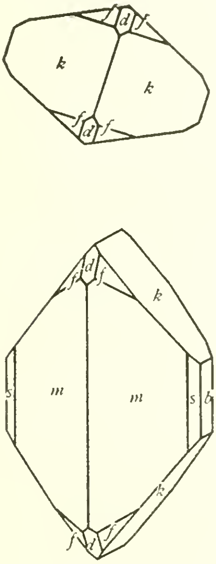
[30] George R. Mansfield and E. S. Larsen, jr. Journ. Wash. Acad. Sci., vol. 5, pp. 463–468, 1915.

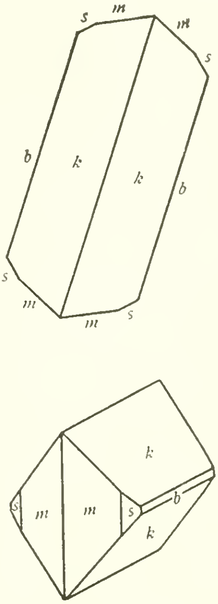
[31] J. B. Umpleby. U. S. Geol. Survey, Bull. 528, p. 88, 1913.

[32] J. B. Umpleby. U. S. Geol. Survey, Bull. 528, p. 89, 1913.

The specimen in question is a banded granular mass made up of about equal parts of granular magnetite and pale brown forsterite. There are small cavities in the forsterite lined with minute tabular forsterite crystals and later filled with calcite. These minute tabular crystals, when lying on the 010 face, give an optical interference figure indicating the obtuse bisectrix perpendicular to this plane with the axial plane across the vertical elongation. The mineral is therefore optically biaxial and positive with X = $\bar{b}$, Y = c, Z = a; 2V very large. The refractive indices are: $\alpha = 1.640$, $\beta = 1.653$, $\gamma = 1.675$. Several trials were made with various dilute acids with a view to dissolving out the calcite filling of the cavities in order to secure crystals for measurement. Practically all acids which dissolve the calcite attack the forsterite sufficiently to destroy the luster, but with acetic acid some measurable crystals were obtained, although they were so dulled as to give very poor measurements. The habit of these is shown in Figure 77 and they give the following forms and angles:



78



79

Figs. 78-79.—78, Olivine. Vertically elongated crystal from black sand from Minidoka. 79, Olivine. Crystal elongated on the a axis

Measurements of forsterite, Figure 77

Form		Symbol		Quality, description	Measured				Calculated			
No.	Letter	Gdt.	Miller		φ		ρ		φ		ρ	
					°	′	°	′	°	′	°	′
1	*a*	0∞	010	Excellent	0	02	90	00	0	00	90	00
2	*n*	∞	110	Medium	65	14	90	00	65	01	90	00
3	*s*	∞2	120	do	47	15	90	00	47	01	90	00
4	*y*	∞5	150	Very poor	22	40	90	00	23	14	90	00
5	*p*	$0\frac{3}{2}$	032	do	0	00	39	05	0	00	41	20
6	*e*	1	111	Fair	66	37	54	06	65	01	54	15

CHRYSOLITE (376)

OLIVINE, PERIDOT

Magnesia-iron silicate, $(2Mg,Fe)O.SiO_2$. Orthorhombic.

Chrysolite or olivine has been reported from several localities as a constituent of basaltic igneous rocks in which it occurs as microscopic grains. It has also been described as a constituent of heavy concentrates from sands worked for placer gold from several localities along Snake River of which the following description is typical.[33]

MINIDOKA COUNTY

While olivine occurs sparingly in all of the sands from Snake River localities as clear pale-yellow angular grains, in several samples from Minidoka it is present as clear pale lemon-yellow crystals with highly lustrous faces. These resemble small topazes or crystals of chrysoberyl and their identity was not suspected until they were measured and found to have the angles of olivine. The dominant forms present are the prism *m*(110) and the dome *K*(021) with the prism *s*(120) and the brachypinacoid *b*(010) less prominent. The macrodome *d*(101) and the pyramid *f*(121) occur rarely as very small faces as shown in Figure 78. The combination of forms is the same on all of the crystals measured, but they vary in development, ranging from short prismatic parallel to the vertical axis (fig. 78) to moderately long prismatic by elongation on the *a* axis (fig. 79). Similar clear yellow olivine grains from other Snake River localities do not show measurable faces. Occasionally the brilliant yellow crystals of olivine have an outer coating of pale brown clay, and many of them contain included grains of magnetite. The forms present were identified by the following measurements:

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[33] Earl V. Shannon. Mineralogy of some black sands from Idaho, etc., Proc. U. S. Nat. Museum, vol. 60, art. 3, p. 27, 1921.

Measurements of olivine from Minidoka

Form		Symbol		Quality, description	Measured		Calculated	
No.	Letter	Gdt.	Miller		φ	ρ	φ	ρ
					° ′	° ′	° ′	° ′
1	*b*	0∞	010	Good	0 00	90 00	0 00	90 00
2	*m*	∞	110	Very good	65 11	90 00	65 01	90 00
3	*s*	∞2	120	Good	47 19	90 00	47 01	90 00
4	*K*	02	021	do	0 00	49 16	0 00	49 33
5	*d*	10	101	Very poor	90 00	50 48	90 00	51 32

SCAPOLITE GROUP (386)

Calcium-aluminium silicates, etc., variable. Tetragonal.

The scapolite group includes a number of silicates of varying composition. These are commonly regarded as consisting of isomorphous end members, marialite and meionite, having the following compositions:

Meionite	$4CaO.3Al_2O_3.6SiO_2.(CO_2,SO_3)$.
Marialite	$3Na_2O.3Al_2O_3.18SiO_2.2NaCl$.

Several intermediate members of the series have received names as listed below. While the optical properties naturally vary somewhat, with the variation in proportions between the CO_2 and SO_3 in the meionite molecule, the various intermediate isomorphous mixtures of the two end members may be identified by the optical properties which are as follows:

Name	Composition		ε	ω	Birefringence
Marialite	Ma_{100} Me_0	Uniaxial (−)	1.537	1.539	0.002
Mizzonite	Ma_{75} Me_{25}	do	1.538	1.551	.013
Wernerite	Ma_{50} Me_{50}	do	1.545	1.567	.022
	Ma_{25} Me_{75}	do			
Meionite	Ma_0 Me_{100}	do	1.560	1.597	.037

The composition of scapolites from Idaho has not been determined by actual analysis and the classifications given below are based upon optical determinations.

ADAMS COUNTY

Scapolite, probably mizzonite (dipyre), occurs in the metamorphic deposits adjacent to granodiorite contacts in the Seven Devils district, and has been especially noted at the Helena mine. It appears to be for the most part confined to the impure shaly portions of the limestone.[34]

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[34] D. C. Livingston and F. B. Laney. Idaho Bur. Mines and Geol., Bull. 1, p. 63, 1920.

CUSTER COUNTY

The complex sodium-calcium silicates of the scapolite group occur rarely in the contact-metamorphic silicate rocks of the Alder Creek (Mackay) district.[35]

LEMHI COUNTY

A specimen of altered calcareous schist from the northeast corner of the Columbia mill, in the Yellow Jacket district, Lemhi County, contains many little veinlets of calcite, scattered quartz grains, pale green hornblende, poikilitic mizzonite, and a few flakes of biotite, each intergrown with or included in the other.[36]

SHOSHONE COUNTY

In the St. Joe-Clearwater region in the southern portion of Shoshone County, and mainly included in the area of the Avery quadrangle, scapolite is abundantly developed by metamorphism in the Newland member of the Belt sedimentary series. The effect of metamorphism is clearly manifested in nearly the whole of the area by the argillaceous layers of this formation, which become altered, for the most part, to chocolate-colored biotitic hornstones of fine texture in which roundish grains of scapolite whose average diameter is about that of buckshot are abundant. On weathered surfaces the scapolite grains are white, in strong contrast with their dark matrix, from which they project in relief.[37]

Through the courtesy of F. C. Calkins a large number of specimens of these scapolite-bearing rocks have been available for examination. The specimens containing rounded or nearly spherical bodies are most abundant. Typical ones of these are shown in Plate 7. The masses of scapolite vary in size and become larger and very poikilitic until they coalesce and form masses which on weathered surface have an organic aspect and resemble fossil algae.

One specimen examined from the St. Joe River, about 1 mile above Siwash Creek, contains nearly spherical and shot-like masses of scapolite which make up over half of the rock. These average 2 mm. in diameter and are prominent on weathered surfaces. They break free from their matrix, which is fine scaly sparkling dark brown material. The scapolite bodies are whitish and opaque on their surface, but where broken they appear translucent with rather resinous luster. Under the microscope the material of the scapolite masses is extremely poikilitic, inclosing so many grains of other minerals as to make its optical properties difficult of determination.

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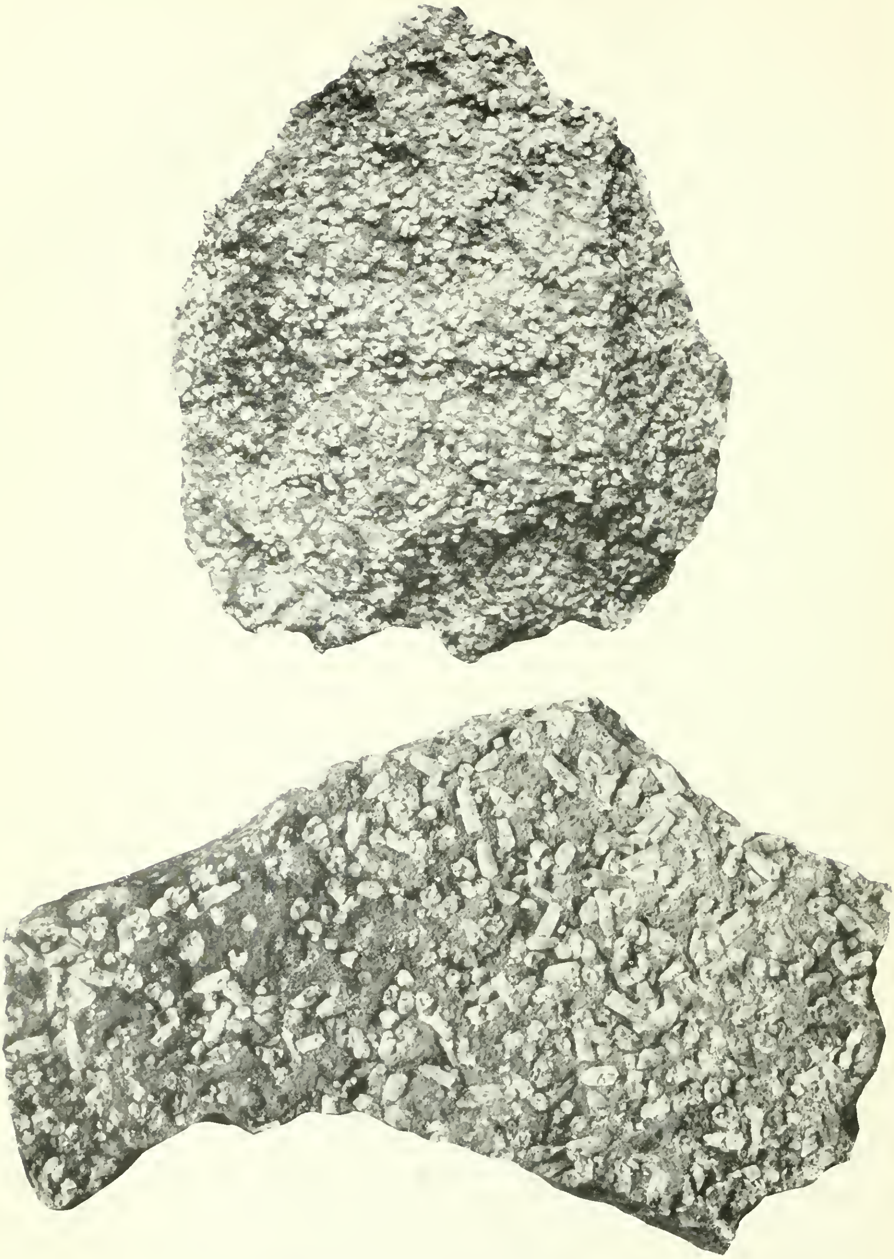
[35] James F. Kemp and C. G. Gunther. Trans. Amer. Inst. Min. Eng., vol. 38, p. 321, 1908.

[36] J. B. Umpleby. U. S. Geol. Surv., Bull. 528, p. 167, 1913.

[37] F. C. Calkins and E. L. Jones, jr., U. S. Geol. Surv., Bull. 530, p. 79, 1913.



Scapolite in Metamorphosed Rocks

For description of plate see page 313

It is uniaxial, negative, and the refractive indices are approximately $\epsilon = 1.545$, $\omega = 1.562$, birefringence 0.017. These identify the material as probably wernerite.

The scapolites often show more or less imperfect crystal form, especially where developed along joints and seams, but the characteristic forms are the rounded shot-like masses (pl. 7, upper). One rock from between Moline and Eagle Creeks contains a large proportion of white fine granular patches associated with scattered spheroids of scapolite 2 mm. in average diameter. The scapolite of this specimen, likewise extremely poikilitic, has $\epsilon = 1.550$, $\omega = 1.570$, birefringence 0.020 and is likewise wernerite.

Typical crystals of the mineral, developed along a joint, are shown in the specimen illustrated in Plate 7, lower. These are not terminated, although some of them show prismatic faces. These have the indices $\epsilon = 1.562$, $\omega = 1.547$, birefringence 0.015. A similar specimen labeled "Lower middle Wallace," from the ridge between the forks of Gold Creek consists of a banded fine grained rock which, in certain bands, contains very minute spherical masses of scapolite. One face of the specimen is coated with dull white scapolite crystals up to 1 mm. by 3 mm. in size, probably originally developed in a seam of calcite later removed. Under the microscope these are clear and transparent as contrasted with the poikilitic character of the spherical masses, and show good prismatic cleavage. The refractive indices are $\epsilon = 1.540$, $\omega = 1.562$, birefringence 0.022.

The poikilitic character of most of the scapolite is probably due to its mode of formation, but may in part be due to alteration. A specimen labeled "Wallace hornfels with large scapolites," from the basin north of Trimmed Tree Hill, consists of rude lusterless white square prisms up to 8 by 30 mm. in size in a schistose micaceous matrix. When crushed and examined under the microscope these are found to contain comparatively very little scapolite, although they probably are the remains of large scapolite crystals. They now consist in the main of what appear to be feldspar, quartz, kaolinite, biotite, and a little diopside.

The optical measurements indicate that the scapolite of the metamorphosed rocks of this area is, in the main, near wernerite in composition.

VALLEY COUNTY

A scapolite near wernerite ($Ma_{30}Me_{70}$) occurs as a constituent of a lime-silicate hornfels formed by the metamorphism of a band of marble in the Yellow Pine mercury mining district. Associated with this in making up the hornfels are quartz, orthoclase, diopside, tremolite, carbonates, and more or less phlogopite, epidote, titanite, magnetite, and apatite.[38]

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[38] E. S. Larsen and D. C. Livingston. U. S. Geol. Surv., Bull. 715, p. 77, 1920.

VESUVIANITE (393)

IDOCRASE

Basic silicate of lime and alumina, in part represented by the formula $2H_2O.\ 12CaO.\ 3(Al, Fe)_2O_3.10SiO_2$. Boron is often present in small amount.

Tetragonal.

Vesuvianite has been reported from only a few localities in Idaho, where it has been collected in association with ore minerals. None of the specimens seen are good mineralogical specimens of the mineral, although a careful search of the localities might obtain cabinet specimens. Vesuvianite, like epidote, lime garnets, etc., is a mineral commonly found in metamorphosed limestone.

BLAINE COUNTY

Vesuvianite occurs as hair-brown long prismatic crystals in wollastonite in a specimen from the Starlight mine in Elkhorn Gulch near Ketchum in the Warm Springs district, Hailey quadrangle. The crystals are deeply striated vertically and reach a length of 15 mm. But few of them are terminated. One which was measured gave the following angles:

Measurements of vesuvianite crystal, Starlight mine

Form		Symbol		Quality, description	Measured		Calculated	
No.	Letter	Gdt.	Miller		φ	ρ	φ	ρ
					° ′	° ′	° ′	° ′
1	*c*	0	001	Fair		0 00		0 00
2	*b*	0∞	010	do	0 00	90 00	0 00	90 00
3	*m*	∞	110	Fair, striated	45 00	90 00	45 00	90 00
4	*f*	∞2	120	Poor, dull	27 14	90 00	26 34	90 00
5	*t*	3	331	do	45 00	66 56	45 00	66 19

The habit, as will be seen from the drawing, (fig. 80) is prismatic and very simple.

CUSTER COUNTY

Umpleby [39] found vesuvianite in the No. 4 crosscut of the Alberta tunnel, Alder Creek district, where it occurred as bunches of acicular radiating crystals which replace dull-gray manganese stained limestone. The largest bunches are 15 mm. in diameter. Another specimen labeled "Actinolite in garnet rock from 100 feet in Alberta No. 4," which is stated to be abundant here, consists of vesuvianite forming a streak 1 cm. wide and several centimeters long in dense brown garnet rock. The vesuvianite is greenish-brown in color and acicular in structure, being made up of close packed elongated prisms of the mineral. Its refractive indices are $\epsilon=1.702$, $\omega=1.708$. It is uniaxial and negative. For the most part the prisms show only the faces of the prismatic zone and these deformed largely by confinement by adjacent crystals during growth. One minute cavity filled with calcite showed several terminations and one of these was measured with sufficient accuracy to identify the forms. One of these, approximating the indices (174) appears to be new but requires confirmation. The habit is prismatic as shown in Figure 82. The measurements are as follows:

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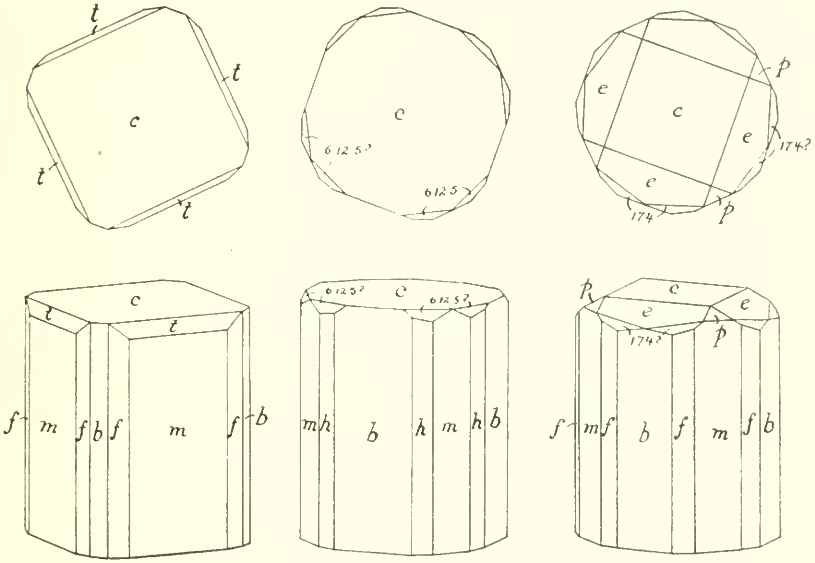
[39] J. B. Umpleby. U. S. Geol. Surv., Prof. Paper 97, p. 55, 1917.



80 81 82

Figs. 80–82.—80, Vesuvianite. Brown crystal from Starlight mine, Wood River district, Blaine County. 81, Vesuvianite. Showing form (6.12.5), Basin Group, Custer County. 82, Vesuvianite. Showing form 174, Mackay, Custer County

Measurements of vesuvianite from Mackay, Figure 82

Form		Symbol		Quality, description	Measured		Calculated	
No.	Letter	Gdt.	Miller		φ	ρ	φ	ρ
					° ′	° ′	° ′	° ′
1	*c*	0	001	Excellent	--------	0 00	--------	0 00
2	*a*	0∞	010	Very good	0 36	90 00	0 00	90 00
3	*m*	∞	110	Excellent	45 35	90 00	45 00	90 00
4	*f*	∞2	120	Medium, blurred	26 08	90 00	26 34	90 00
4	*o*	01	011	Very good	0 00	28 15	0 00	28 15
6	(?)	$\frac{1}{4}\,\frac{7}{4}$	174?	Poor	7 36	43 26	8 08	43 32
7	*p*	1	111	Very poor	45 51	--------	45 00	-------

Specimens from the Basin group prospect which has been mentioned under hedenbergite and andradite and which is located near the point where the Ketchum-Mackay road crosses the Trail Creek divide at the head of Big Lost River, contain hair-brown prisms of vesuvianite associated with masses of greenish-brown garnet. These, like those previously described, are vertically elongated imperfectly developed crystals. One which was measured is illustrated in Figure 81. This shows one form which appears to have the indices (6–12–5), but it is doubtful. The measurements are as follows:

Measurements of vesuvianite, Figure 81, Basin Group

Form		Symbol		Quality, description	Measured		Calculated	
No.	Letter	Gdt.	Miller		φ	ρ	φ	ρ
					° ′	° ′	° ′	° ′
1	*c*	0	001	Good		0 00		0 00
2	*a*	0∞	010	Very good	0 00	90 00	0 00	90 00
3	*m*	∞	110	Good	45 00	90 00	45 00	90 00
4	*f*	∞3	130	do	18 46	90 00	18 26	90 00
5	(?)	$\frac{6}{5}\,\frac{12}{5}$	6. 12. 5	Poor	26 03	56 14	26 34	55 16

ZIRCON (394)

Zirconium silicate, $ZrO.SiO_2$. Tetragonal.

Zircon is known from Idaho only as a constituent of heavy sands concentrated fron gold-placer washings. It is widely distributed in such sands, being especially common in association with monazite. Like the monazite much of the zircon is probably derived from the granite by disintegration of that rock or of small pegmatitic segregations in it. Ordinarily the mineral is clear and colorless and it is invariably in beautifully sharp and clear crystals, most of which are very transparent and brilliant but it varies in color through smoky and gray to brown and orange, pink or flesh red. The smoky crystals are much like smoky quartz in coloring and the pigment is often unevenly distributed. Inclusions are frequent, the most highly transparent and brilliant forms containing minute spherical bubble-like cavities and also minute microlite-like prismatic crystals of a transparent colorless mineral having a lower refractive index than the zircon. Many of the translucent smoky gray crystals appear to owe their color to minute inclusions of iron oxide. The several crystals illustrated in Figures 83 to 91, inclusive, from various localities in the State have been measured and the measurements have been previously published so that they need not be repeated here.[40]

ADA COUNTY

A few very minute crystals of zircon occur in a concentrate from a locality on Snake River in Ada County near Boise. These are pyramidal in habit with no prism faces, as shown in Figure 90, and have an orange red color.

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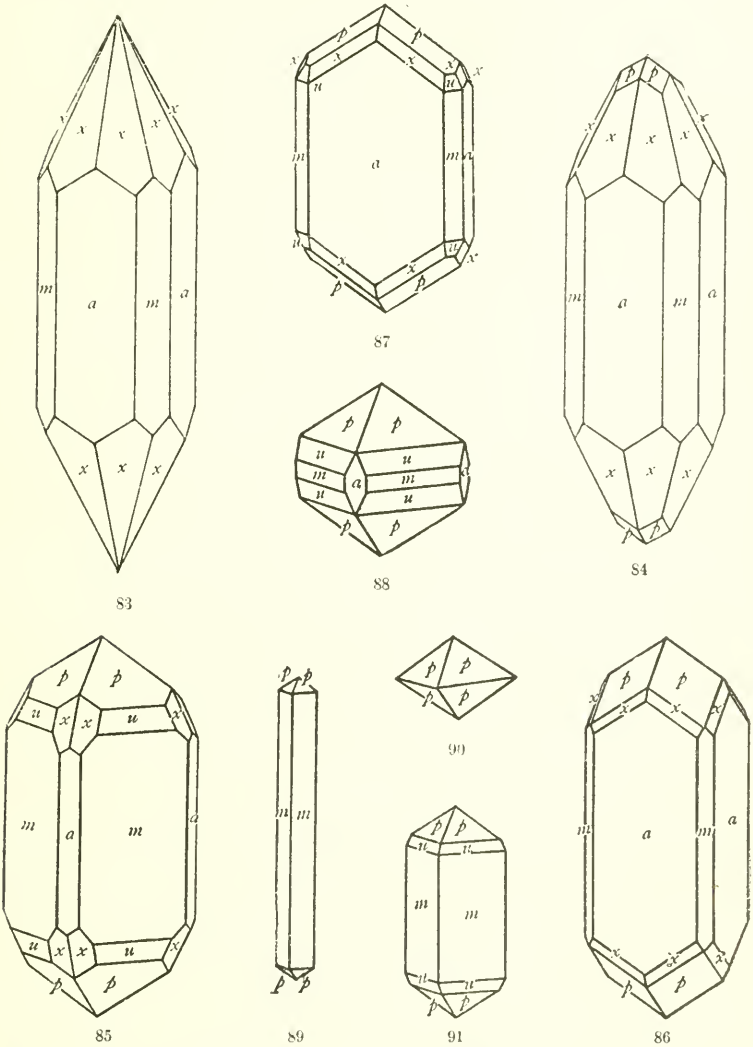
[40] Earl V. Shannon. Mineralogy of some black sands from Idaho, Proc. U. S. Nat. Mus., vol. 60, art. 3, pp. 11–15, 1921.

BINGHAM COUNTY

A sand from Rosa, Bingham County, which is concentrated from a Snake River placer, contains numbers of beautifully sharp colorless prismatic zircon crystals. A few of the zircons of this sand are brown to red-brown in color. Most of these show the prism *m*(110) and the pyramids *p*(111) and *u*(331), developed as shown in Figure 91.


83
x
x
x
x
x
m
a
m
a
x
x
x
87
p
p
x
x
x
x
u
u
m
a
m
u
u
x
x
p
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88
p
p
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p
p

FIGS. 83-91.—ZIRCON CRYSTALS OUT OF BLACK SANDS FROM BOISE AND MINIDOKA COUNTIES

BOISE COUNTY

Zircon, in the usual highly perfect and colorless crystals, is abundant in every placer concentrate from Boise County which has been examined. It is invariably associated with the monazite. In form the zircons are most frequently prismatic with the length 3 to 4 times the diameter and the most abundant types show the first order prism *m*(110) and the second order prism *a*(100) in almost equal development and are terminated by the ditetragonal pyramid *x*(311) either alone (fig. 83) or together with the unit pyramid *p*(111). Crystals of these habits are most numerous, although other habits occur occasionally as noted below. While, except as before mentioned, these crystals are colorless, a sand concentrate consisting largely of monazite from Idaho City contains numerous zircons of this habit which are very like the associated monazite in color.

The crystals vary considerably in development from the typical forms illustrated in Figures 83 and 84, the first order prism in some cases being the larger form with its angles truncated by the second order prism (fig. 85) while in other cases the relative development of the two prisms is reversed (fig. 86). The terminations vary also, in some cases the ditetragonal pyramid being alone or merely truncated at its extreme summit by the pyramid *p*(111), while in other crystals the unit pyramid *p*(111) is largely developed reducing the ditetragonal pyramid to small faces (fig. 85). Not infrequently these two extremes are observed at opposite ends of the same crystal, producing a peculiarly hemimorphic aspect. Some variants of the common development are difficult to orient as, for instance, when the faces of the form *x*(311) are very unequally developed and reduce the prism faces to irregular polygons of small size. The pyramid *u*(331) is occasionally present, usually as small and dull faces which give poor measurements. A coarse screened portion of a sand from Idaho City consisting largely of ilmenite contains translucent zircon crystals of two types, both of which are somewhat different from the normal small crystals occurring in the finer screenings of the same lot of sand. The most abundant of these two types is peculiarly tabular to a face of the second order prism *a*(100) as shown in Figure 87. The other crystals of this lot have a short pyramidal habit with *p*(111) prominent and *u*(331), *m*(110), and *a*(100) about equally developed as shown in Figure 88. These are irregular and appear as though made up of numerous, very small, individuals, in parallel position. The reflections from the faces are consequently poor.

A sample of concentrate rich in columbite and samarskite from Idaho City contains a few small brownish crystals of the simple pyramidal habit shown in Figure 90.

CAMAS COUNTY

A sample of placer concentrate from Cow Creek, Camas County, contains rare crystals of zircon like those of Boise County associated with gold, garnet titanite, etc.

CLEARWATER COUNTY

Placer concentrates from the Pierce district contain zircon of the usual type but not abundantly. Scarce highly perfect transparent crystals occur with ilmenite and garnet in a sand from Rhodes Creek, Pierce City, and similar crystals are decidedly rare in concentrates labeled Pierce City and Cow Creek-Pierce district. Monazite is about as abundant as the zircon in these sands which consist largely of ilmenite and rose red garnet.

ELMORE COUNTY

A concentrate marked "Zircon, Big Rock placer claim, Wood Creek, Elmore County," consists predominantly of minute colorless zircon crystals.

IDAHO COUNTY

Zircon is reported to be very abundant in some of the placers of the Warren and Florence districts where the heavy residues of the sluices are called "white sand" because of its predominance.[41]

Not many samples from this county have been examined. Two separation products labeled "Zircon," one from Salmon River and the other from the Baboon placer, Elk City, consist predominantly of minute colorless zircon crystals of the usual types.

MINIDOKA COUNTY

Zircon is very rare in concentrates from Snake River sands from Minidoka, Wapi, and 8 miles east of Wapi, which consist largely of augite and ilmenite with less garnet and olivine. A few crystals of orange red color and the habit illustrated in Figure 91 were seen in a sand from Minidoka and also some which are long prismatic with the length 10 to 20 times the diameter. These are pale pink in color and show only the unit prism $m(110)$ and the pyramid $p(111)$, as shown in Figure 89.

TOPAZ (397)

Aluminum fluosilicate, $Al(F,OH)_2$. $AlSiO_4$. Orthorhombic.

The few occurrences of topaz, well known as a gem stone, which have thus far been reported in Idaho are as follows:

CASSIA COUNTY

White topaz was reported to have been found at City of Rocks, 5 miles north of Moulton, Cassia County, in 1919.[42] This material was not topaz, as shown later, but colorless quartz crystals.[43]

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[41] Waldemar Lindgren. U. S. Geol. Survey, 20th Ann. Rept., pt. 3, p. 234, 1900.

[42] U. S. Geol. Survey, Mineral Resources of United States for 1919, pt. 2, p. 179.

[43] Miles E. North, Reno, Nev. Personal letter, 1920.

CLARKE COUNTY

Several good topaz crystals, colorless, and pale yellow prisms up to 7 mm. in diameter are reported to have been found by Mr. C. A. McCafferty, of Ideman, on Camas Creek.[44]

IDAHO COUNTY

A clear bluish topaz of great size was found in gold-bearing gravel on a tributary to Paddy Creek in the Warren district.[45]

ANDALUSITE (398)

Aluminium silicate, $Al_2O_3.SiO_2$. Orthorhombic.

The following localities for andalusite in Idaho have been reported:

BLAINE COUNTY

Andalusite occurs as small grains and crystals as a contact mineral in metamorphosed shales at the contact of the large granitic mass west of Hailey in the Wood River district.[46]

LEMHI COUNTY

Andalusite (chiastolite) is reported to occur with garnet and amphibole in metamorphosed Algonkian sedimentary rocks in Lemhi County.[47]

SHOSHONE COUNTY

In the metaporphosed rocks surrounding the quartz-monzonite batholith of the Coeur d'Alene mining district andalusite is developed in some of the more aluminous beds of the Prichard formation in close proximity to the contact. This mineral forms prismatic knots a few millimeters long in a black metamorphosed slate, derived from the Prichard, near the monzonite contact on the Dobson Pass road, but although present in many other localities this mineral is not elsewhere conspicuous megascopically because of its occurrence in small irregular individuals without crystal form. Where it is abundant, however, it gives the rock a pinkish tinge.[48]

VALLEY COUNTY

Andalusite occurs in the Yellow Pine quicksilver mining district in Valley County. The original sandstones and quartzose conglomerates have been altered to hard quartzites and the less pure sandstones to quartz schists. A specimen of the schist collected as typical of the thick layer on the ridge southwest of the Smith camp proved to be made up mostly of andalusite with some quartz, phlogopite, sericite, magnetite, and rutile.[49]

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[44] H. T. Stearns. U. S. Geol. Survey. Oral communication.

[45] Waldemar Lindgren. U. S. Geol. Survey, 20th Ann. Rept., pt. 3, p. 243, 1900.

[46] Waldemar Lindgren. U. S. Geol. Survey, 20th Ann. Rept., pt. 3, p. 195, 1900.

[47] J. B. Umpleby. U. S. Geol. Survey, Bull. 528, p. 31, 1913.

[48] F. L. Ransome and F. L. Calkins. U. S. Geol. Survey, Prof. Paper 62, p. 50, 1908.

CYANITE (400)

Aluminium silicate, $Al_2O_3.SiO_2$. Triclinic

The only important locality for cyanite thus far known in Idaho is in Shoshone County.

SHOSHONE COUNTY

Cyanite is frequently developed in metamorphosed sedimentary rocks of the Belt series in the southern portion of Shoshone County, especially in the southern half of the area of the Avery topographic sheet. The mineral occurs in micaceous schists as prismatic rude crystals, some of which reach a length of 30 cm. Many of these are coated on the outside with mica and a considerable proportion of them are completely altered to pseudomorphs of mica. Fine specimens may be obtained in places. Some specimens, the exact locality for which was not learned, contain abundant fine blue blades in small segregated quartz veins and green blades in micaceous schist adjacent to such veins. A specimen from 2½ miles south of Trimmed Tree Mountain contains pale blue blades of cyanite up to 5 mm. in width by 3 cm. in length in a coarse matrix of chlorite, biotite, feldspar, and black tourmaline.

GADOLINITE (404)

Basic silicate of beryllium, iron, and
yttrium, approximating the formula
$2BeO.FeO.2Yt_2O_3.2SiO_2$. Monoclinic.

The only reference to the occurrence of the rare earth mineral gadolinite in Idaho is found in an analysis published in a Russian journal.[50] The locality of the mineral is not given more definitely than simply Idaho in North America. The gadolinite analyzed had a specific gravity of 4.382. The analysis gave the following results:

Analysis of gadolinite from Idaho

(G. Chernik (Tschernick), analyst)

	Per cent
Beryllium oxide (BeO)	9. 98
Ferrous iron (FeO)	12. 74
Magnesia (MgO)	. 21
Lime (CaO)	. 60
Silica (SiO_2)	24. 41
Thoria (ThO_2)	. 30
Yttria (Y_2O_3)	42. 94
Ceria (Ce_2O_3)	1. 94

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[49] E. S. Larsen and D. C. Livingston. Geology of the Yellow Pine mining district, Idaho. U. S. Geol. Survey, Bull. 715, p. 78, 1920.

[50] Chernik. Journ. Soc. Phys. Chim. Russe., vol. 36, pp. 25-27 and 287-301, 1904; abstract Zeitschr Kryst. vol. 43, p 78, 1907.

	Per cent
Lanthana (La_2O_3), Praesia (Pr_2O_3), Neodymia (Nd_2O_3)	5. 52
Alumina (Al_2O_3), soda (Na_2O) and potash (K_2O)	Trace.
Water (H_2O)	. 48
Total	99. 12

A second mineral occurring as dark bottle green inclusions in the gadolinite was also analyzed with the following results:

Analysis of mineral included in gadolinite

(G. Chernik (Tschernick), analyst)

	Per cent
Yttria (Yt_2O_3)	51. 94
Ceria (Ce_2O_3)	14. 49
Silica (SiO_2)	26. 08
Beryllia (BeO)	. 54
Thoria (ThO_2)	2. 77
Ferrous iron (FeO)	1. 58
Lime (CaO)	. 62
Magnesia (MgO), Manganese (MnO), potash (K_2O), soda (Na_2O)	Trace.
Water (H_2O)	. 97
Total	98. 99

The specific gravity of the latter mineral is 4.536. Chernik states that it is a variety of gadolinite with the formula $16(Y_2O_3.2SiO_2).2(2Ce_2O_3.3SiO_2).\ ThSiO_4.Be_2SiO_4.2FeO.CaO.5H_2O$.

Doelter[51] gives as the formula for the gadolinite of the first analysis:

$$3(Be.Fe)O.Y_2O_3.2SiO_2=Be_2FeY_2Si_2O_{10}$$

and for the mineral of the second analysis:

$$\overset{II}{R}_5\ \overset{III}{R}_{40}\ \overset{IV}{R}Si_{40}O_{147}.5H_2O$$

with $RO : R_2O_3 : SiO_2$ as 0.3 : 1 : 2. Doelter states that this can not be gadolinite and is either a mixture or a new mineral.

ZOISITE (406)

Calcium-aluminium silicate, $4CaO.3Al_2O_3.6SiO_2.H_2O$. Orthorhombic.

Zoisite, both the ordinary whitish-colored material and the pink variety which is called thulite, have been identified microscopically in the Seven Devils district in Adams County and a single lot of specimens of zoisite from the Avery quadrangle in Shoshone County has been examined.

ADAMS COUNTY

Zoisite occurs in the Seven Devils district as a contact mineral as described by Livingston and Laney.[52] At some places, notably the

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[51] C. Doelter. Handbuch der Mineralchem., vol. 2, p. 179, 1915.

[52] D. C. Livingston and F. B. Laney. Idaho Bur. Mines and Geol., Bull. 1, pp. 48, 62, etc., 1920.

Arkansaw and Helena mines, the feldspars of the altered granite have a decidedly pinkish tinge due to the alteration and development in them of a pink mineral, probably the pink variety of zoisite, thulite. In some specimens the pink mineral is abundant, especially so in veinlets which seem to have developed along fractures in the granite. While no chemical work has been done on this mineral its optical properties indicate that it is thulite. All of the feldspars, whether pink or not, contain much zoisite.

In the Red Ledge mine—a low-grade disseminated deposit in porphyritic and fragmental andesite—zoisite is rather widely distributed throughout the rock, and in some places, notably in the highly mineralized rock forming the ore shoot in the main tunnel, it is abundant. It is usually formed as irregular masses of interlocking crystals or blades, and was apparently developed from both the feldspathic material in the groundmass and the feldspar phenocrysts. Much of it occurs in the vicinity of more or less completely altered phenocysts.

SHOSHONE COUNTY

Several specimens from a locality southeast of and across a branch of the Clearwater River from Goat Peak near the southeast corner of the Avery quadrangle contain zoisite in prismatic crystals in a quartz gangue. The specimens, which are from a surface outcrop, are somewhat iron stained. The zoisite is abundant as rude prisms up to 1 cm. thick by 2 cm. long. Adjacent to the walls of the veins the quartz contains some biotite and garnet. Where unstained by limonite the zoisite crystals are dirty white in color. They possess the usual cleavage parallel to $b(010)$, are unterminated, and are bounded simply by the unit prism $m(110)$ which is somewhat rounded and striated. Under the microscope the mineral is filled with small inclusions, aligned in a vertical direction, but is otherwise transparent and colorless. It is biaxial positive with 2V medium small, dispersion strong, $r<v$. The optical orientation is $X=c$, $Y=\bar{b}$, $Z=a$, and the refractive indices are $\alpha=1.700$, $\beta=1.703$, $\gamma=1.718$, all ± 0.003.

A sample was separated from quartz by methylene iodide, the staining limonite removed by treatment with hydrochloric acid, and a few grains of garnet removed with an electromagnet. This was analyzed with the following results:

Analysis of zoisite from Avery quadrangle

(E. V. Shannon, analyst)

	Per cent
Silica (SiO_2)	39. 20
Alumina (Al_2O_3)	33. 22
Ferric iron (Fe_2O_3)	2. 14
Lime (CaO)	23. 90
Barium oxide (BaO)	Trace.

	Per cent
Magnesia (MgO)	0. 16
Water (H_2O—ignition)	2. 04
Total	100. 66

The composition is thus that of a nearly iron-free zoisite.

CLINOZOISITE (406a)

Calcium aluminium silicate, $4CaO.3Al_2O_3.6SiO_2.H_2O$. Monoclinic.

ADAMS COUNTY

Clinozoisite is listed, without further description, by Livingston and Laney[52a] as occurring in the contact-metamorphic copper deposits of the Seven Devils district.

EPIDOTE (407)

Silicate of lime, ferric iron and alumina, $H_2O.4CaO.3(Al,Fe)_2O_3.6SiO_2$. Monoclinic.

Epidote is a silicate which frequently occurs with other minerals of similar origin at the contact of intrusive igneous rocks with limestone, and also is found in a variety of other situations. The most important locality thus far known in Idaho is in the Seven Devils district in Adams County which, if carefully exploited, is probably capable of furnishing fine cabinet specimens of this mineral.

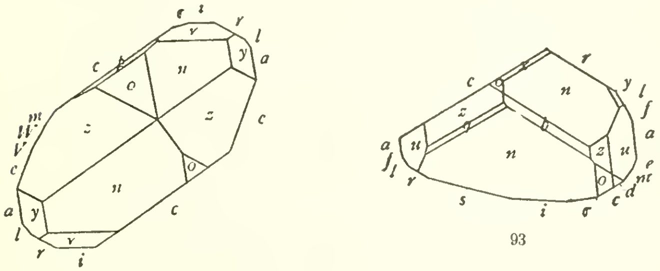
ADAMS COUNTY

In Adams County epidote is abundant in the copper deposits of the Seven Devils district, which are typical contact-metamorphic deposits in limestone. The mineral has been described by Palache,[53] whose description is largely reprinted in the following. The epidote occurs in the Peacock and other mines in deep-green crystals in cavities in the massive epidote. These crystals are sometimes unusually large and fine, some of them reaching a length of 30 cm. or more. Many of them are flattened parallel to the base $c(001)$ giving them a lozenge shape in cross section. They have the normal epidote habit being elongated parallel to the b axis and are almost invariably attached by an end of this axis. The majority of these elongated crystals are terminated simply by $n(\bar{1}11)$; others also have $b(010)$ and in the orthodome zone they show $c(001)$, $i(\bar{1}02)$, $r(\bar{1}01)$, and $a(100)$. Some crystals are much richer in forms as shown in Figures 92 and 93, which are orthographic projections on the clinopinacoid showing distortion. Twinning is common according to the usual law with the twinning plane *a*(100). One crystal showed repeated twinning with two narrow lamellae between the two major individuals. Many of the crystals shell off in concentric shells parallel to all the crystal faces, even the smallest faces preserving their luster and permitting good measurements after the surface layers have been removed. This shelly structure gives rise to a beautiful iridescence on the faces of the crystals and is generally associated with a bleaching of the color presumably due to surface alteration. Some crystals are embedded in quartz of later growth which is the latest deposit in the cavities. Some epidote crystals embedded in quartz from the Decorah mine are doubly terminated. The forms noted by Palache on epidote crystals from this district are:

[52a] Idaho Bur. Mines and Geol., Bull. 1, p. 62, 1920.

[53] Charles Palache. Amer. Journ. Sci., vol. 8, p. 299, 1899.

$c(001)$
$a(100)$
$m(102)$
$W(305)$
$v(405)$
$e(101)$
$(\bar{1}03)$
$i(\bar{1}02)$
$r(\bar{1}01)$
$l(\bar{2}01)$
$z(110)$
$o(011)$
$p(016)$
$n(\bar{1}11)$
$y(\bar{2}11)$
$\eta(\bar{2}12)$
$f(\bar{3}01)$
$s(\bar{2}03)$
$u(210)$
$x(\bar{1}12)$
$d(111)$
$g(\bar{2}21)$



92

93

FIGS. 92–93.—EPIDOTE CRYSTALS FROM THE SEVEN DEVILS DISTRICT, ADAMS COUNTY. ORTHOGRAPHIC PROJECTIONS ON *b*(010). AFTER PALACHE

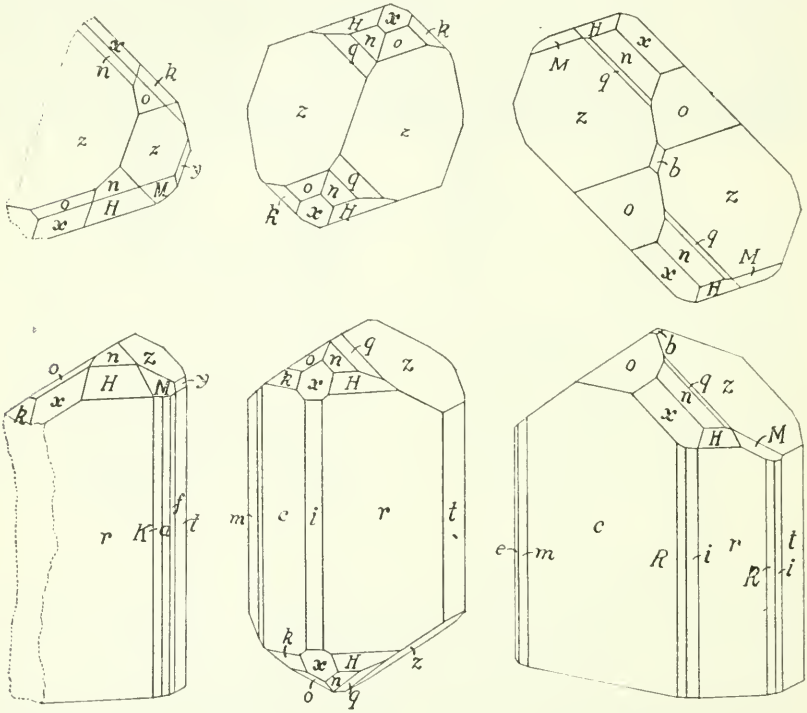
A number of specimens from this district which have been examined by the writer may be briefly described. Chunks of material occurring abundantly scattered over the hill south of the Kleinschmidt grade on the first ridge east of Snake Canyon consist of massive fine-grained epidote forming a dense rock.

Specimens from the Fidelity claims consist of pale green imperfect prisms and coarse fibrous masses with quartz and calcite and of radiating light pistachio-green prisms in white quartz.

One lot from the Queen mine dump consists of bright pistachio-green columnar masses in garnet and a second lot consists of imperfectly crystallized light to dark green masses with well crystallized brown garnet.

Specimens from the Copper Boy mine consist of masses of large blackish-green crystals deformed by mutual interference. Occasionally good terminations project into chrysocolla filled cavities. The habits of these are the same as those described below from the Peacock mine. Some garnet and specular hematite are associated with this epidote.

Specimens from the Peacock mine consist in part of radiating columnar green masses in brown garnet and also of pistachio to blackish-green prismatic crystals up to 5 cm. in length, some of the smaller of which present measureable terminations. The drawings, Figures 94, 95, and 96, show crystals from this locality, all drawn in abnormal position with the elongation vertical. The first crystal, which was broken, is shown in Figure 94. This is distorted in the manner illustrated by Palaches Figure 93, above. It was measured with the elongation vertical and furnished the angles of the following table:


x
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94 95 96

FIGS. 94-96.—EPIDOTE CRYSTALS FROM THE PEACOCK MINE, SEVEN DEVILS DISTRICT. DRAWN WITH *b* AXIS (ELONGATION) VERTICAL

Measurements of epidote crystal, Figure 94, ($\bar{b}$) elongation vertical

Form		Symbol		Quality, description	Measured				Calculated			
No.	Letter	Gdt.	Miller		φ''		ρ''		φ''		ρ''	
					°	'	°	'	°	'	°	'
1	*c*	0	001	Very good	63	36	90	00	64	36	90	00
2	*t*	∞0	100	do	0	00	90	00	0	00	90	00
3	*z*	∞	110	Excellent	0	00	35	15	0	00	35	00
4	*y*	3∞	310	Very poor	0	00	65	23	0	00	64	33
5	*e*	10	101	Very good	29	23	90	00	29	54	90	00
6	*m*	½0	102	do	41	26	90	00	42	06	90	00
7	*r*	$-\bar{1}0$	$\bar{1}01$	Excellent	$\overline{51}$	45	90	00	$\overline{51}$	42	90	00
8	*K*	−0	$\bar{3}02$	Medium	$\overline{34}$	46	90	00	$\overline{35}$	07	90	00
9	*a*	−20	$\bar{2}01$	do	$\overline{25}$	35	90	00	$\overline{25}$	58	90	00
10	*f*	−30	$\bar{3}01$	do	$\overline{16}$	25	90	00	$\overline{16}$	46	90	00
11	*o*	01	011	Fair	63	43	31	30	64	36	31	31
12	*k*	0½	012	Medium	63	30	50	26	64	36	50	48
13	*d*	1	$\bar{1}11$	do	29	43	48	17	29	54	48	01
14	*n*	−1	$\bar{1}11$	Good	$\overline{51}$	30	34	54	$\overline{51}$	42	35	13
15	*x*	−½	$\bar{1}12$	Very poor	$\overline{83}$	57	48	21	$\overline{81}$	03	48	16
16	*M*	−21	$\bar{2}11$	Medium	$\overline{25}$	55	51	38	$\overline{25}$	58	51	41
17	*H*	−1½	$\bar{2}12$	Good	$\overline{51}$	30	54	23	$\overline{51}$	42	54	41

The same crystal, partly remeasured in normal position gave the following angles:

Measurements of epidote, Figure 94, normal position

Form		Symbol		Quality, description	Measured				Calculated			
No.	Letter	Gdt.	Miller		φ		ρ		φ		ρ	
					°	'	°	'	°	'	°	'
1	*t*	∞0	100	Very good	9	00	90	00	90	00	90	00
2	*z*	∞	110	Excellent	35	14	90	00	35	00	90	00
3	*o*	01	011	Good	15	10	62	00	14	44	61	49
4	*k*	0½	012	Medium	28	37	46	00	27	44	45	34
5	*n*	−1	$\bar{1}11$	Good	$\overline{23}$	33	62	51	$\overline{23}$	37	63	06
6	*x*	−½	$\bar{1}12$	Very poor	$\bar{8}$	56	42	48	$\bar{9}$	53	42	30
7	*M*	−21	$\bar{2}11$	Poor	$\overline{48}$	48	69	52	$\overline{48}$	41	69	55
8	*H*	−1½	$\bar{2}12$	Good	$\overline{41}$	05	49	55	$\overline{41}$	10	50	11

The crystal illustratd in Figure 95 is doubly terminated and is rather short prismatic in habit. This is likewise drawn with the elongation vertical although it was measured in normal position and gave the following angles:

Measurements of epidote, Figure 95, normal position

Form		Symbol		Quality, description	Measured				Calculated			
No.	Letter	Gdt.	Miller		φ		ρ		φ		ρ	
					°	'	°	'	°	'	°	'
1	*c*	0	001	Fair	90	00	26	27	90	00	25	24
2	*t*	∞0	100	Good	90	00	90	00	90	00	90	00
3	*z*	∞	110	Excellent	35	37	90	00	35	00	90	00
4	*o*	01	011	do	14	42	62	02	14	44	61	49
5	*k*	0½	012	Medium poor	28	10	45	51	27	44	45	34
6	*e*	+10	101	Good	90	00	60	41	90	00	60	06
7	Θ	+20	201	Very poor	90	00	70	10	90	00	71	35
8	*m*	+½0	102	Good	90	00	48	41	90	00	47	54
9	*r*	$-\bar{1}0$	$\bar{1}01$	Medium	$\overline{90}$	00	38	19	$\overline{90}$	00	38	18
10	*i*	−½0	$\bar{1}02$	do	$\overline{90}$	00	8	24	$\overline{90}$	00	8	57
11	*n*	−1	$\bar{1}11$	Very poor	$\overline{23}$	43	63	08	$\overline{23}$	37	63	06
12	*x*	−½	$\bar{1}12$	Very good	$\bar{9}$	50	42	37	$\bar{9}$	53	42	30
13	*H*	−21	$\bar{2}12$	Very poor	$\overline{41}$	57	50	36	$\overline{41}$	10	50	11

The crystal illustrated in Figure 96, also measured with the elongation vertical, gave the angles recorded in the following table:

Measurements of epidote crystal, Figure 96, elongation ($\bar{b}$) vertical

Form		Symbol		Quality, description	Measured		Calculated	
No.	Letter	Gdt.	Miller		φ''	ρ''	φ''	ρ''
					° ′	° ′	° ′	° ′
1	*c*	0	001	Good	63 38	90 00	64 36	90 00
2	*t*	∞0	100	Very good	0 04	90 00	0 00	90 00
3	*z*	∞	110	Excellent	0 00	35 09	0 00	35 00
4	*e*	+10	101	Fair	29 29	90 00	29 54	90 00
5	*m*	$+\frac{1}{2}0$	102	Medium	41 10	90 00	42 06	90 00
6	*r*	−10	$\bar{1}01$	Excellent	$\overline{51}$ 53	90 00	$\overline{51}$ 42	90 00
7	*i*	$-\frac{1}{2}0$	$\bar{1}02$	Good	$\overline{81}$ 37	90 00	$\overline{81}$ 03	90 00
8	*R*	$-\frac{1}{3}0$	$\bar{1}03$	do	$\overline{86}$ 07	90 00	$\overline{86}$ 57	90 00
9	*a*	−20	$\bar{2}01$	Very poor	$\overline{26}$ 53	90 00	$\overline{25}$ 58	90 00
10	new?	$-\frac{7}{8}0$	$\bar{7}05$(?)	Good	$\overline{41}$ 33	90 00	$\overline{40}$ 18	90 00
11	*o*	01	011	Excellent	64 04	31 22	64 36	31 31
12	*n*	−1	$\bar{1}11$	do	$\overline{51}$ 24	35 05	$\overline{51}$ 42	35 13
13	*x*	−½	$\bar{1}12$	do	$\overline{81}$ 23	48 00	$\overline{81}$ 03	48 16
14	*q*	−2	$\bar{2}21$	Poor	$\overline{25}$ 52	32 28	$\overline{25}$ 58	32 19
15	*H*	−1½	$\bar{2}12$	Very good	$\overline{51}$ 33	54 35	$\overline{51}$ 42	54 41
16	*M*	−21	$\bar{2}11$	Good	$\overline{25}$ 33	51 46	$\overline{25}$ 58	51 41

BLAINE COUNTY

A specimen of massive dark green epidote from Blaine County has been sent to the National Museum for identification by B. Z. Smith, of Mountainhome, Idaho.

CLEARWATER COUNTY

Portions of deep green well-formed crystals of epidote up to 3 cm. in diameter are present in considerable number in a coarse concentrate from placer gravels in Clearwater County associated with rutile, corundum, tourmaline, garnet, etc.

CUSTER COUNTY

Epidote is very rare in the contact-metamorphic copper deposits of the Alder Creek (Mackay) district as contrasted with its abundant occurrence in the deposits of similar genesis in the Seven Devils district.

Specimens from the Basin prospect on the mountain across Park Creek from the point where the Ketchum-Mackay road crosses the Trail Creek divide, contain epidote associated with garnet, hedenbergite, vesuvianite, wollastonite, prehnite, galena, etc. The epidote occurs especially as the lining of small open spaces which were later filled with prehnite. The epidote seems to be the latest of the silicate minerals except the prehnite, but some perfect doubly terminated crystals of epidote are completely surrounded by prehnite. The crystals are all of simple lath shape elongated on the $\bar{b}$ axis and flattened parallel to ($\bar{1}01$). The orthodome zone contains broad faces of ($\bar{1}01$) with narrower faces of ($\bar{1}05$), (103), (101), (301) and, in one case, a face giving the indices (10.0.1). The epidotes are minute, rarely over 2 mm. long and are limpid transparent yellow-green in color.

LEMHI COUNTY

In Lemhi County epidote is often strikingly developed in the recrystallized sedimentary rocks and also occurs as a contact mineral in the Mayflower group of claims in the Mackinaw district. The deposits here consist of quartz replacements along a brecciated zone in siliceous schist. The brecciated material is locally almost entirely made up of garnet with associated epidote and magnetite.[54] At the Carmen Creek mine in the Carmen Creek district the ore occurs as lenses of quartz distributed through a band of schist 8 to 15 feet wide, the quartz totaling about one-third of the width. Much of the schist itself is mineralized. In addition to the metallic minerals actinolite and magnetite are widely developed; green epidote is less common. Magnetite occurs in the vein quartz but the actinolite and epidote are confined to the adjacent schist.[55]

OWYHEE COUNTY

Epidote is of common occurrence in places in the Silver City district where it replaces basalt or some other igneous rock adjacent to the silver veins. It is for the most part massive with aphanitic appearance and the usual yellow green or pistachio green color. A specimen from a raise 1,300 feet from the portal of the Blaine tunnel shows this fine grained epidote replacing basalt adjacent to the silver vein. A number of specimens from the dump of a tunnel on the south side of Long Gulch below the Blaine tunnel contain epidote. In the first of these small yellow-green epidote crystals replace fragments of altered rock inclosed in the quartz-adularia vein. In another, massive epidote haloes surround fragments of the igneous rock included in the vein and, in the third, a breccia of basalt fragments is cemented by quartz and massive yellow-green epidote, the latter in masses up to 2 by 6 cm. in size.

No epidote has been seen from the contact-metamorphic ore-bodies of the South Mountain district.

SHOSHONE COUNTY

Epidote occurs as dull-green aphanitic veins and surfaces of imperfect curved opaque greenish-yellow crystals lining fractures in an altered basic dike on the Corby claim on Pine Creek.

PREHNITE (411)

Calcium aluminium silicate, Orthorhombic.
$H_2O.2CaO.Al_2O_3.3SiO_2$.

Prehnite has been found in Idaho in two contact metamorphic deposits in Custer County, associated with garnet and epidote, etc.

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[54] J. B. Umpleby. U. S. Geol. Survey, Bull. 528, p. 155, 1913.

[55] J. B. Umpleby. U. S. Geol. Survey, Bull. 528, p. 127, 1913.

Its occurrence in this association is of interest as it forms a link connecting such lime-silicate contact phenomena with the formation of zeolite-bearing veins in which prehnite is commonly found elsewhere. A single specimen from Kootenai County contains prehnite associated with zeolites.

CUSTER COUNTY

J. B. Umpleby reports prehnite as occurring in the ore of the Phi Kappa mine in Phi Kappa Canyon, tributary to upper Lost River in the Hailey quadrangle.[56] He also found it in specimens from the Basin group on the mountain nearly due north of and across Park Creek from the point where the Ketchum-Mackay road crosses the Trail Creek divide. Specimens from the latter locality have been examined in detail. The prehnite occurs in a rock largely composed of brown garnet as the filling of small cavities up to 3 cm. in diameter, which are lined with transparent green prismatic epidote crystals up to 5 mm. long, the prehnite evidently being the youngest mineral of the aggregate. Occasional isolated grains of sphalerite and galena occur in the prehnite.

The prehnite is colorless to white and transparent to translucent in the hand specimen. It does not form free crystals but is in bladed cleavable masses. Close inspection is necessary to detect the mineral as the cleavage is not conspicuous and the prehnite closely resembles quartz to the naked eye. Under the microscope in powder the mineral is colorless and transparent and is biaxial positive with 2V medium and moderate dispersion, $r>v$. It exhibits the confused twinned structure and anomalous optical behaviour characteristic for the species. Sections perpendicular to an optic axis show no extinction but abnormal interference colors. The refractive indices, though somewhat variable, average $\alpha=1.626$, $\beta=1.629$, $\gamma=1.652$, all $\pm .003$; Birefringence, $\gamma-\alpha=0.026$.

A sample, purified by means of heavy solutions, was analyzed with the following results:

Analysis of prehnite, Basin prospect

(E. V. Shannon, analyst)

	Per cent
Silica (SiO_2)	42. 26
Alumina (Al_2O_3)	24. 65
Ferric oxide (Fe_2O_3)	2. 10
Lime (CaO)	26. 86
Magnesia (MgO)	. 04
Barium oxide (BaO)	None.
Water (H_2O) above 110° C	4. 72
Water (H_2O) below 110° C	None.
Total	100. 63

The composition shown by the analysis is that of normal prehnite.

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[56] J. B. Umpleby. Personal letter 1923, to be published in report by the U. S. Geological Survey on the Hailey quadrangle.

KOOTENAI COUNTY

A specimen from Post Falls contains prehnite associated with stilbite, laumontite, etc., in a seam in a diabasic rock. The prehnite forms minute tabular crystals lining cavities as well as white to greenish granular masses. Optically the mineral of this occurrence is biaxial positive with 2V approximately 60°. The acute bisectrix is perpendicular to the tabular face of the crystals. The dispersion $r<v$ is weak and the anomalous twinned structure and unusual optical effects often exhibited by this mineral were not noted. The refractive indices are $\alpha=1.614$, $\beta=1.624$, $\gamma=1.640$.

The specimen, which was received from Mr. Henry Fair, of Spokane, is from a claim upon which the owner has pretended to have found rubies and diamonds, arousing local interest.

CUSTERITE (413a)

Calcium fluosilicate, $CaO.Ca(OH,F)_2.SiO_2$ Monoclinic.

Some specimens collected by Dr. Joseph B. Umpleby from the metamorphosed limestone of the Alder Creek (Mackay) district were found, upon laboratory investigation, to be a new mineral. This was named custerite after the county in which it occurs.[57]

CUSTER COUNTY

The custerite occurs in finely granular masses of a dirty greenish-gray to white color, intimately mixed with magnetite, in a group of prospects a short distance beyond the crest of the high ridge northwest of the Copper Bullion tunnel. It occurs in the inner edge of a fringe of garnet-diopside rock which surrounds a large limestone inclusion in the granite porphyry.[58] The mineral is fairly abundant and specimens of the usual size can be obtained showing about equal parts of custerite and magnetite (as shown in pl. 8, lower).

Schaller [59] has discussed the composition, properties, and relationships of the mineral and his discussion is given below.

The results of microscopic study indicate that custerite is monoclinic. Two cleavages were noted, one parallel to the base and the other parallel to the prism. The hardness is 5 to 6, density 2.91. The crystals show lamellar twinning like albite. The indices of refraction for sodium light are $\alpha=1.586$, $\beta=1.589$, $\gamma=1.598$, birefringence 0.012, all ± 0.005. The mineral is characterized, microscopically, by its moderate index of refraction, low birefringence, polysynthetic twinning, maximum extinction of twin lamellae of 6° to 7°, positive optical character, distinct dispersion of the optic axes with $r>v$ and three cleavages which intersect at high angles.

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[57] J. B. Umpleby, W. T. Schaller, and E. S. Larsen. Amer. Journ. Sci., vol. 36, p. 385, 1913.

[58] J. B. Umpleby. U. S. Geol. Survey, Prof. Paper 97, p. 52, 1917.

[59] Waldemar T. Schaller. U. S. Geol. Survey, Bull. 610, p. 152, 1916.

There is no known mineral species from which it may not readily be distinguished optically. Its birefringence and twinning suggest albite, but its refractive indices are much higher. Its relief, lack of color, and cleavage in thin section might at first glance lead to its being mistaken for a colorless pyroxene, but its refringence and birefringence are lower and its extinction angle is less than in all pyroxenes except aegirite. It is believed that custerite is a mineral of rare occurrence, for its optical properties are so distinctive that it would scarcely have been overlooked. In the hand specimen, however, it is so unpromising in appearance that thin sections of it may never have been cut. The mineral should be looked for in fluorine-bearing contact zones, apparently in the border phases of metamorphism.

When heated gently in the closed tube custerite turns a transitory yellow and phosphoresces with a golden yellow light. As seen in a darkened room the color of the glow is like that of a deep colored golden beryl. On increasing the heat the phosphorescence is destroyed and water is given off. The mineral does not decrepitate. A white ring due to fluorine is obtained by heating the mineral at a temperature sufficient to melt the glass tube. In the blowpipe flame custerite fuses with difficulty to an opaque white enamel.

The mineral is very readily decomposed by acids, gelatinous silica separating so quickly when the powdered mineral is treated with hydrochloric acid (HCl) as to form a stiff coherent mass. The separated gelatinous silica floats around in an excess of acid the solution itself not gelatinizing on further boiling. Custerite therefore does not "gelatinize" like natrolite.

The chemical analyses showed that water, fluorine, silica, and lime were the essential constituents, the small amounts of iron and magnesium present being probably due to magnetite and diopside, respectively. Fairly fresh material suitable for analysis was available in portions only of 0.25 to 0.75 gram. The analytical results are shown in the following table:

Analysis and Ratios of Custerite

(W. T. Schaller, analyst)

	(1)	(2)	Average	Ratios
Silica (SiO_2)	32.13	32.20	32.17	0.536
Lime (CaO)	55.11		55.11	.984
Water (H_2O)	5.53	5.06	5.30	.294
Fluorine (F)	8.12		8.12	.427
Magnesia (MgO)	1.19	1.19	1.19	.030
Magnetite	.85	1.14	1.00	
Total			102.89	
Less oxygent equivalent to fluorine			3.42	
Net total			99.47	

These results were verified by a partial analysis (water not being determined) of a different somewhat less pure portion of the same specimen of custerite. The results obtained are: SiO_2 33.46, CaO 53.93, F 7.29, MgO 1.41, magnetite 2.13. Alkalies were not determined on any of the samples because of paucity of material. Some of the whiter chalky-looking material gave less water than the fresh material, several different samples yielding 2 to 3 per cent H_2O instead of the 5 or 6 per cent given in the above analyses. Whether this represents an alteration of the custerite or merely a much impurer sample could not be determined on the scanty material available.

The formula derived for custerite is Ca_2SiHFO_4 with some of the fluorine replaced by water (hydroxyl). The composition may be also expressed as a mixture of two compounds, $2SiO_2.4CaO.2H_2O$ and $2SiO_2.4CaO.4F$, with the first one slightly in excess. The relation of fluorine to water (hydroxyl) can be much better shown in the empirical formula according to which the ratios reduce to $Ca_4Si_2O_6(OH, F)_4$ with the ratio of hydroxyl (OH) to fluorine (F) as 2.48 : 1.79 or nearly 4 : 3.

No water was given off when custerite was heated to 110°, indicating that the water is an inherent part of the mineral. The temperature at which the water does go off was not determined, but the observation was repeatedly made that the phosphorescence phenomenon displayed itself and was destroyed by heat before the water was given off. Some powdered custerite, placed in a watch glass with several cubic centimeters of water, immediately gives a deep red color with a few drops of phenolpthalein. This reaction was described by Clarke, who has suggested that it is indicative of the presence of the univalent group CaOH. Custerite is related most nearly to the minerals cuspidine, hillebrandite, and zeophyllite.

CHONDRODITE (415)

Magnesium fluosilicate, $4MgO.2SiO_2.Mg(F, OH)_2$. Monoclinic.

Chondrodite is a mineral usually occurring in metamorphosed limestone but is characteristic of limestones which have suffered regional metomorphism rather than of the lime-silicate zones of igneous contacts. The only occurrence of this mineral that has thus far been recorded in Idaho is in Custer County, where a lens of chondroditic limestone was found by Prof. L. G. Westgate in mapping the geology of the Hailey Quadrangle in 1914.

CUSTER COUNTY

Chondrodite occurs in abundance in crystalline limestone from a locality near a small lake in a cirque at the head of Wildhorse Canyon at the east side of Mount Hyndman. The mineral forms rounded irregular grains from 1 to 2 mm. in diameter which make up approximately half of the rock, the other major constituent being crystalline calcite. The chondrodite shows no definite crystal faces when the calcite is removed by solution in acid. In the hand specimen it appears as grains of the usual resin-brown color. Under the microscope in powder the chondrodite is clear, transparent, and devoid of cleavage; is yellow-brown in color and distinctly pleochroic X = rich golden brown, Y = pale brownish yellow, Z = very pale brownish yellow; absorption, $X > Y > Z$. It is biaxial positive (+) with 2V medium large, dispersion, $r > v$, distinct. Refractive indices $\alpha = 1.631$, $\beta = 1.640$, $\gamma = 1.657$, all ±0.005, birefringence, $\gamma - \alpha = .026$. Associated with the chondrodite are a deep bottle green isotropic spinel with a refractive index of 1.735 ± .002, and less of a colorless micaceous mineral which is nearly or quite uniaxial and positive with a refractive index of approximately $\beta = 1.598$. This is doubtless clinochlore.

ILVAITE (417)

LIEVRITE, YENITE

Hydrous lime-iron silicate, $H_2O.CaO.4FeO.Fe_2O_3.4SiO_2$. Orthorhombic.

The rare calcium-iron silicate, ilvaite, has been found in the South Mountain mining district in Owyhee County in crystals which, in size and perfection, are equal to the best known from any locality in the world.[60]

OWYHEE COUNTY

The ilvaite occurs in the ores of the Golconda and perhaps other mines in typical contact-metamorphic deposits. A large area of fine grained granite or granodiorite here adjoins an area of highly metamorphosed sedimentary rocks, largely schists, quartzites, and marble. In a broad band of marble near the granite there is a series of masses of contact-metamorphic minerals including hedenbergite, garnet, and ilvaite, carrying in some places pyrrhotite, chalcopyrite, sphalerite, and galena. The minerals are aggregated in the irregular manner of contact-metamorphic deposits, the ilvaite being in bunches scattered through the masses. The specimens of ilvaite consist of imperfectly crystallized black masses associated with granular reddish-brown garnet; of unterminated crystals having good prismatic planes, embedded in quartz; of large crystals embedded in calcite patches in a fine-grained hedenbergite rock; and of large and fine terminated prismatic crystals embedded in soft limonitic gossan (pl. 8, upper).

The unterminated crystals embedded in quartz are commonly prismatic and are deformed by mutual interference but some of

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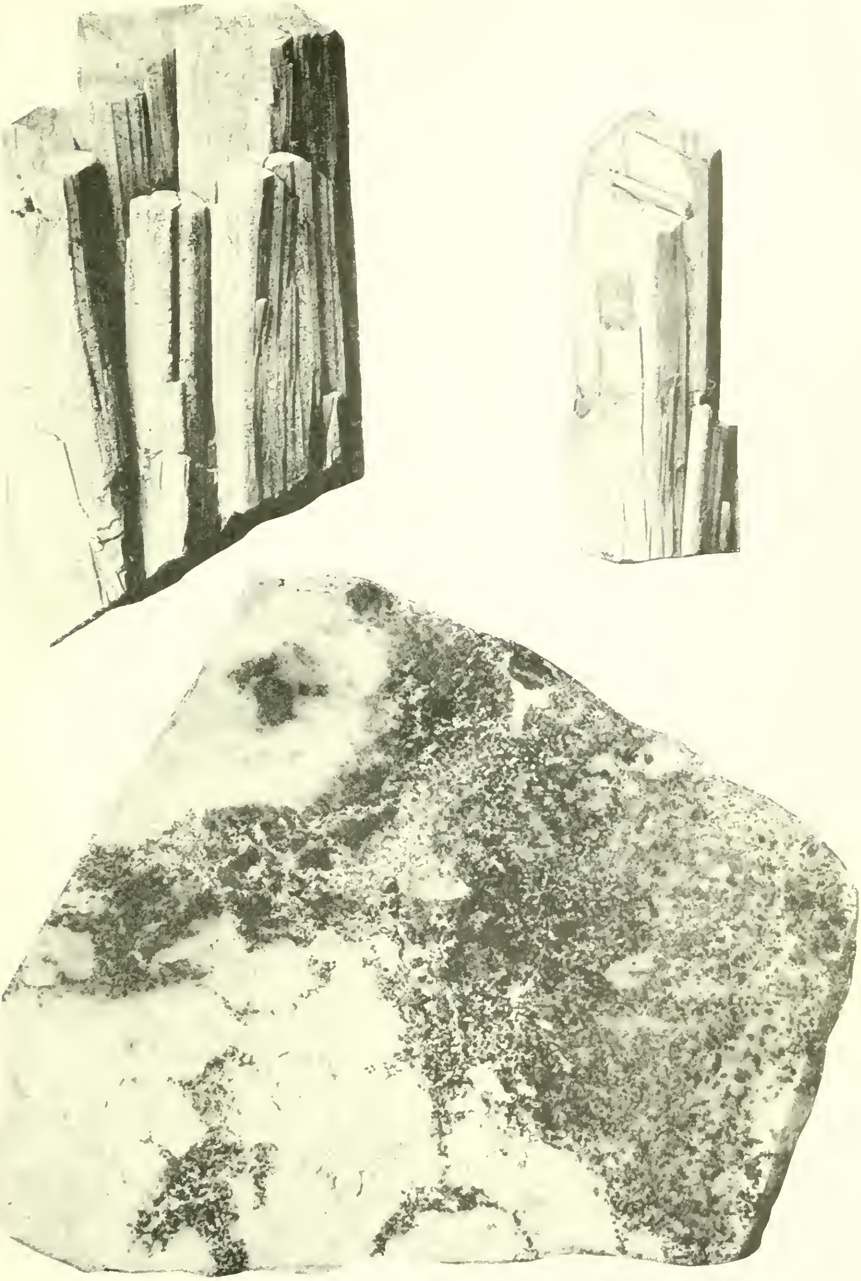
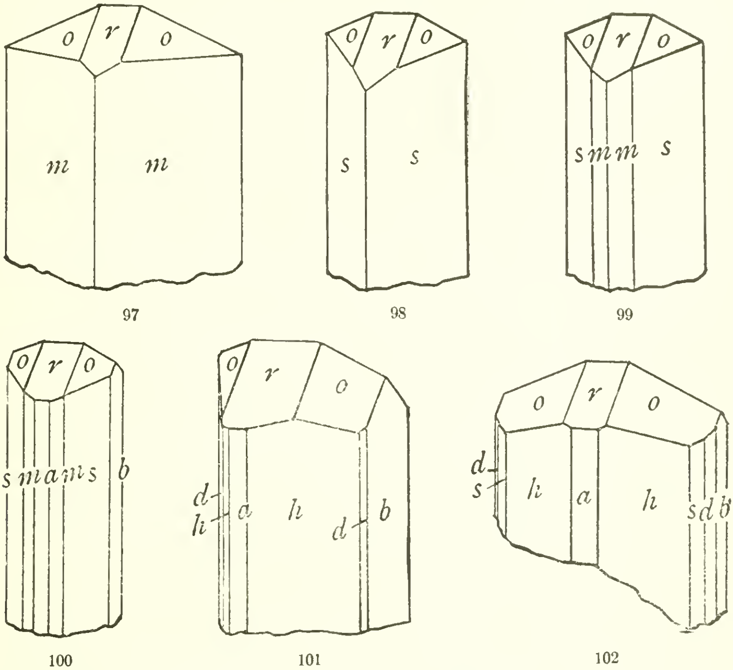
[60] Earl V. Shannon. Amer. Journ. Sci., vol. 45, p. 118, 1918.



ILVAITE AND CUSTERITE

FOR DESCRIPTION OF PLATE SEE PAGES 331 AND 334

them, when removed from the inclosing quartz, are suitable for measurement on the reflecting goniometer. Only the prismatic zone is represented, these embedded crystals, so far as observed, being unterminated by crystal faces. The most common habits of the embedded crystals are like the prism zones of Figures 97 to 100, although all the forms observed in this zone on the terminated crystals were also found on the embedded crystals. The crystals are often deeply striated and rounded, apparently by oscillation between the prisms *m*(110) and *s*(120). They greatly resemble black tourmaline and upon casual examination might be mistaken for that mineral. The forms present on one of the best of these crystals were identified as: *a*(100), *b*(010), *m*(110), *h*(210), *s*(120), and *d*(140).



Figs. 97–102.—Ilvaite crystals from Golconda mine, South Mountain mine, Owyhee County

The measurements obtained on one of the crystals occurring embedded in quartz are compared with the angles given by Dana for the species as follows:

	Observed		Average	Calculated, Dana
	(1)	(2)		
	° ′	° ′	° ′	° ′
$m:m'''$	66 38	67 46	67 12	67 22
$h:h'''$	37 28	38 00	37 44	36 52
$s:s'$	72 42	73 10	72 56	73 45

This agreement with the calculated angles is as close as was obtained on any of the crystals measured. That there should be a discrepancy is not at all surprising in view of the character of the faces which are rounded and do not give sharp signals. Usually the faces give a band of signals a degree or more wide with a central more distinct cross which was measured. Where no central more distinct cross was present it was necessary to take the mean between the two ends of the band. Vicinal faces seem common on ilvaite from other localities and this occurrence is no exception. In measuring the prism zone of any of the crystals distinct signals are often noted from narrow planes which give complex indices and differ from crystal to crystal.

The best specimens of the Idaho ilvaite are the well terminated prisms like those illustrated in Plate 8. The smallest of these is the single large prismatic crystal about 6 cm. long and averaging perhaps 1.5 cm. in diameter with some smaller attached crystals. The second and larger specimen consists of an aggregate of such crystals in roughly parallel position. Attached to or projecting from these larger crystals were a number of small terminated prisms and it was upon these that most of the measurements were made. When received the specimens were covered with a thin film of brownish limonite of the ocherous gossan in which they were embedded. Scrubbing with a stiff brush removed all of the limonite and left the crystals clean and lustrous. Some drusy coatings of calcite were also easily removed leaving no scar upon the ilvaite. The ilvaite crystals are fragile and liable to crumble if roughly handled owing to the presence in them of minute irregular cracks which thoroughly traverse the mineral somewhat after the fashion of glass which has been heated and plunged into water. This fracturing of the crystals is probably traceable to strains incident upon volume changes in the associated and inclosing minerals during oxidation and hydration.

Frequently a crystal seems to have been split longitudinally and the two halves slightly displaced this discrepancy, in one case, reaching five degrees. The fracture is parallel to $b(010)$, the most prominent cleavage, and is not visible on the crystal, being located on a deeply striated face. Its location is clearly shown on the projection made from the measurements.

The terminated crystals show the same forms in the prism zone as do the crystals embedded in quartz, and the faces are not so good. The crystals are frequently distorted or unsymmetrical, as shown in Figure 101, where a form may be present as a broad face on one side of the crystal and absent or represented only as a narrow line on the opposite side. The results obtained in measuring the terminal faces were unsatisfactory. The only measurement of the angle $r : r'$ over c, which was obtained, gave the value 67° 02′ which is 09′ short of the value given by Dana. For the interfacial angle $o : o'''$ the value given by Dana is 40° 29′ and the angles obtained on the Idaho crystals vary from 36° 34′ to 42° 45′. The variation is in part probably due to splitting of the crystals parallel to (010) and in part due to vicinal forms in the same zone.

The Idaho Ilvaite has been analyzed by Hillebrand with the following results.[61]

Analysis of Ilvaite, Golconda mine

(W. F. Hillebrand, analyst)

	Per cent
Silica (SiO_2)	29. 16
Alumina (Al_2O_3)	. 52
Ferric iron (Fe_2O_3)	20. 40
Ferrous iron (FeO)	29. 14
Manganese oxide (MnO)	5. 51
Lime (CaO)	13. 02
Magnesia (MgO)	. 15
Soda (Na_2O)	. 08
Water (H_2O) below 110° C	. 15
Water (H_2O) above 110° C	2. 64
Total	100. 77

In the Idaho ilvaite cleavage is present but not conspicuous parallel to b(010). The fracture is uneven, hardness 5.75; specific gravity 4.059 (Hillebrand). The luster is vitreous and not submetallic as described from other localities; color, black; streak black with faint brownish tinge. The mineral is rather difficultly fusible before the blowpipe and upon fusion it intumesces slightly and yields a black magnetic bead. It is readily soluble in hot hydrochloric acid, yielding an amber solution which gelatinizes.

Several unsuccessful attempts were made to cut oriented sections of the crystals for optical examination, but the mineral is too opaque to transmit sufficient light in the thinnest sections which could be ground.

CALAMINE (423)

Basic zinc silicate, $H_2O.2ZnO.SiO_2$ Orthorhombic, hemimorphic.

Calamine is a secondary zinc mineral always occurring as an alteration product of sphalerite in the oxidized portions of zinc-bearing ore deposits, where it is commonly associated with smithsonite and usually also with limonite and cerusite. The several Idaho occurrences are not important as zinc ores although fair mineral specimens have been obtained from each.

CASSIA COUNTY

Bluish-white to white radiating sheaves and druses of minute thin tabular calamine crystals occur in cavities in a chalky cellular white rock from the Black Pine mining district in Cassia County (Cat. No. 89,130, U.S.N.M.).

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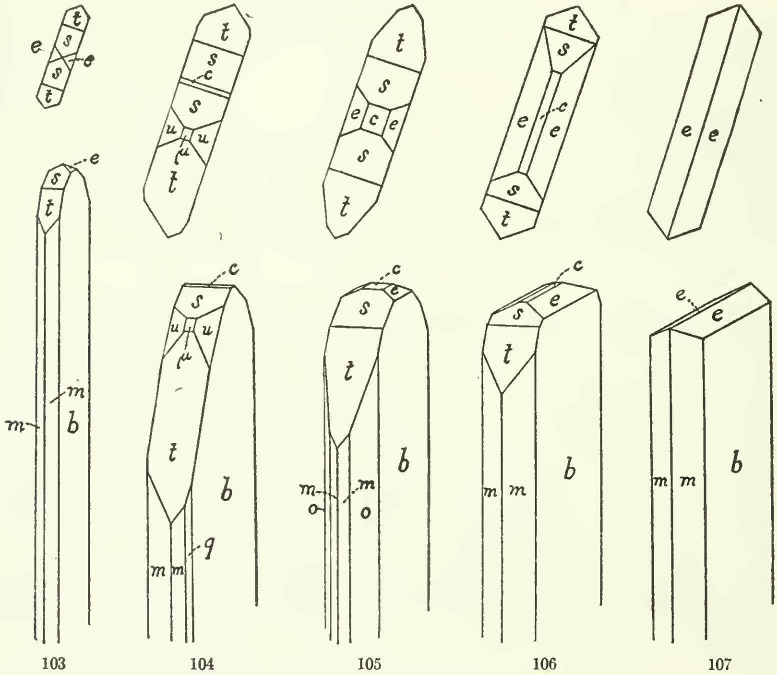
[61] W. F. Hillebrand. U. S. Geol. Survey Bull. 591, p. 318.

CUSTER COUNTY

In the Alder Creek district a little calamine occurs as acicular crystals set on a base of smithsonite in the Champion group prospect south-southeast of the Empire mine and at an elevation of 8,000 feet, south of Cliff Creek.[62] It is very rare here. A very few minute bladelike crystals of colorless calamine occur with the aurichalcite described elsewhere in this bulletin, in a specimen from three sets above the No. 4 level of the Empire mine at Mackay.



FIGS. 103–107.—CALAMINE CRYSTALS. 103, 104, PITTSBURG-IDAHO MINE, LEMHI COUNTY. 105, PACIFIC MINE, CUSTER COUNTY. 106, RED BIRD MINE, CUSTER COUNTY. 107, BEARDSLEY MINE, CUSTER COUNTY

In Northwestern Custer County calamine occurs as bundles of clear white columnar crystals protruding from the walls of small cavities in the oxidized lead-silver ores of the Bay Horse district, particularly the Red Bird, Beardsley, River View, and Pacific mines.[63] A specimen from the River View mine consists of radiated-compact white calamine making up a cellular mass.

Specimens from the Red Bird mine consist of botryoidal masses having a limonite-stained drusy surface made up of minute calamine crystals on which rest a few tiny white cubes of fluorite. The calamine crystals are vertically elongated and flattened parallel to the

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[62] J. B. Umpleby U. S. Geol. Survey, Prof. Paper 97, p. 50, 1917.

[63] J. B. Umpleby. U. S. Geol. Survey, Bull. 539, p. 52, 1913.

b(010) face. The habit is illustrated in Figure 106. One which was measured gave the following angles:

Calamine crystal, Red Bird mine, Figure 106

Form		Symbol		Quality, description	Measured		Calculated	
No.	Letter	Gdt.	Miller		φ	ρ	φ	ρ
					° ′	° ′	° ′	° ′
1	*c*	0	001	Very poor, minute	-- --	0 00	-- --	0 00
2	*b*	0∞	010	Good	0 22	90 00	0 00	90 00
3	*m*	∞	110	do	51 34	90 00	51 55	90 00
4	*s*	10	101	Very good	89 47	30 59	90 00	31 22
5	*ϑ*	½0	102	Very poor	90 00	16 34	90 00	16 57
6	*t*	30	301	Good	90 03	61 26	90 00	61 20
7	*e*	01	011	do	0 10	25 28	0 00	25 32

Specimens from the Pacific mine contain sheaves of white calamine crystals in cavities of galena-quartzite ore and also colorless crystals of calamine on drusy quartz associated with cerusite in oxidized ore. The crystals are similar to those last described from the Red Bird mine, except that the clinodome *e*(011) is not so prominent. The habit of crystals from this mine is shown in Figure 105. These gave the following measurments:

Measurements of calamine crystals, Pacific mine, Figure 105

Form		Symbol		Quality, description	Measured		Calculated	
No.	Letter	Gdt.	Miller		φ	ρ	φ	ρ
					° ′	° ′	° ′	° ′
1	*c*	0	001	Poor, dull	--------	0 00	--------	0 00
2	*b*	0∞	010	Poor, rounded	0 31	90 00	0 00	90 00
3	*m*	∞	110	do	50 05	90 00	51 55	90 00
4	*o*	∞3	130	do	22 12	90 00	23 03	90 00
5	*e*	01	011	Good	0 30	25 37	0 00	25 32
6	*s*	10	101	Fair	90 20	31 28	90 00	31 22
7	*t*	30	301	Very good	90 19	61 35	90 00	61 20

Specimens from the Beardsley mine show similar minute crystals forming druses with malachite and calcite on a siliceous matrix, and on chrysocolla. The latter crystals have the very simple habit shown in Figure 107, the only forms present being *b*(010), *m*(110), and *e*(011).

LEMHI COUNTY

Calamine occurs in Lemhi County, particularly in the Pittsburg-Idaho and other mines of the Texas district in oxidized lead-silver ores in the usual beautiful needle crystals, usually set on a drusy base of smithsonite, as in the specimen illustrated by Umpleby.[64] A specimen labeled as from the 400 foot level, Flat vein, Pittsburg-Idaho mine consists of manganese-stained clayey material containing cavities lined with long slender deeply striated calamine crystals of the habit illustrated in Figure 103. Upon measurement these gave the following angles:

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[64] J. B. Umpleby. U. S. Geol. Survey, Bull. 528, pp. 75, 103, pl. 10, 1913.

Measurements of calamine crystal, Pittsburg-Idaho mine, Figure 103

Form		Symbol		Quality, description	Measured		Calculated	
No.	Letter	Gdt.	Miller		φ	ρ	φ	ρ
					° ′	° ′	° ′	° ′
1	*b*	0∞	010	Poor, striated	0 00	90 00	0 00	90 00
2	*m*	∞	110	do	49 59	90 00	51 55	90 00
3	*e*	01	011	Very poor	0 00	25 05	0 00	25 32
4	*s*	10	101	Fair	89 54	31 55	90 00	31 22
5	*t*	30	301	do	89 54	61 18	90 00	61 20

The prism zone is deeply striated and rounded by oscillation between *b*(010) and *m*(110).

The specimen illustrated by Umpleby from this mine contains numerous sheaves of the white bladed crystals resting upon smithsonite. These are flattened parallel to *b*(010). Some of them are unsymmetrically developed and then have a peculiarly monoclinic aspect. On such is illustrated in the drawing, Figure 104. This gave the following measurements:

Measurements of calamine crystal, Pittsburg-Idaho mine, Figure 104

Form		Symbol		Quality, description	Measured		Calculated	
No.	Letter	Gdt.	Miller		φ	ρ	φ	ρ
					° ′	° ′	° ′	° ′
1	*b*	∞0	010	Fair, blurred	0 00	90 00	0 00	90 00
2	*m*	∞	110	do	51 08	90 00	51 55	90 00
3	*q*	∞5	150	Poor	15 03	90 00	14 19	90 00
4	*c*	0	001	Fair, minute		0 00		0 00
5	*s*	10	101	Good	89 50	31 42	90 00	31 22
6	*t*	30	301	Poor, dull	90 38	60 57	90 00	61 20
7		20	201	Dull, n. s	90 00	(n. s.)	90 00	50 39
8	*u*	21	211	Good	68 35	52 49	68 36	52 38

In these crystals again the prismatic zone is strongly striated vertically and the interfacial angles are rounded by oscillation.

OWYHEE COUNTY

A single specimen in the Museum collections (Cat. No. 65653, U.S.N.M.) from the Laxley mine, South Mountain district, contains calamine as drusy crusts of minute crystals and drusy surfaced globular masses lining cavities in compact limonite. The calamine crystals are normal in habit and tend to be aggregated into cockscomb like forms or groups.

TOURMALINE (426)

Complex borosilicate, with the general formula: $12SiO_2.3B_2O_3.9(Al_2O_3.3RO).3H_2O$.	Rhombohedral, Hemimorphic.

Tourmaline is in reality a group of minerals represented by the above generalized formula and varying greatly in composition by variation between alumina and the bases represented by RO in the above formula and also in the character of the latter which may be ferrous iron, manganese, lime, magnesia, potash, soda, lithia, etc., giving rise to several varieties which have received separate names. With the single exception of the Boise County occurrence, the tourmaline thus far found in Idaho localities is all of the black iron-bearing variety which passes under the varietal name schorl or schorlite. This variety has no commercial use or value. The occurrences are described in detail as far as known in the following:

BLAINE COUNTY

Ordinary iron tourmaline in coarse imperfect black crystals was found in the pegmatitic rock occurring in blocks in the talus at the head of the cirque on the south flank of Mount Hyndman, by the writer while assisting Prof. L. G. Westgate in the mapping of the areal geology of the Hailey quadrangle for the United States Geological Survey. This tourmaline presented no unusual features.

A specimen sent to the National Museum for identification by B. A. Smith, of Martin, Idaho, consists almost entirely of tourmaline. The specimen is from a claim belonging to Mr. Smith in the Lava Creek district 20 miles west of Arco. The tourmaline forms radial fibers aggregated into spherulitic masses up to 5 mm. across and is greenish to brownish-black in the hand specimen with a silky luster. A little quartz is associated with the tourmaline in making up the rock. Under the microscope the mineral appears as slender prisms of negative elongation and parallel extinction which are intensely pleochroic in colorless to pale violet-brown parallel to the elongation and deep blue-gray to brownish-blue across the elongation. The refractive indices are $\epsilon=1.647$, $\omega=1.671$.

BOISE COUNTY

A specimen of a bluish gray mineral sent to the United States Geological Survey for identification from the Boise Basin has been identified as tourmaline by Dr. Waldemar T. Schaller. The mineral is in flat blades, which have the optical properties of the elbaite variety of tourmaline. It is easily fusible before the blowpipe and gives the characteristic boron flame. The tourmaline blades are associated with and contained in a rusty limonite stained sericite such as is common accompanying veins in the Boise Basin region.

CLEARWATER COUNTY

Black and quite well formed, though broken, crystals of tourmaline up to 2 cm. in diameter occur in placer concentrates from Pierce, Clearwater County (Cat. No. 87504, U.S.N.M.). The concentrates contain also corundum, epidote, garnet, etc. The tourmaline is probably associated with the corundum in its original source as one small crystal of tourmaline was seen embedded in a corundum crystal.

LATAH COUNTY

In Latah County ordinary black tourmaline occurs in rough crystals in the pegmatites which are mined for mica in the vicinity of Avon. This mineral is also frequently abundant in bands of the inclosing schist adjacent to the pegmatite masses.[65]

LEMHI COUNTY

Tourmaline occurs abundantly in some of the ores of the Blackbird district associated with cobaltite as a microscopic mineral, with quartz, making up quartz-tourmaline rocks, as first determined by Frank L. Hess of the United States Geological Survey. Specimens collected by Mr. Hess from the Haynes Stellite Co. mine on Blackbird Creek, 2 miles from its mouth, in the hand specimen appear as very fine grained gray masses showing no minerals distinguishable to the unaided eye except sparsely scattered large steel-gray grains which have been shown by analysis to be danaite, the cobaltiferous variety of arsenopyrite. When this ore is polished, however, the surface appears as a black gangue containing very abundant and extremely minute reddish gray metallic particles of cobaltite. The black gangue is quartz-tourmaline rock. When this ore is powdered to pass a 200 mesh sieve the constituent grains of the fine aggregate are separated and under high magnification appear as sharply octahedral or cuboctahedral crystals of the opaque metallic mineral and grains of quartz and tourmaline. The tourmaline forms either equidimensional irregular grains or very stout prisms, the elongation twice the diameter or less. It is strongly pleochroic, ϵ = very pale violet brown to brownish gray, ω = deep gray-blue. The refractive indices measured are $\epsilon = 1.635$, $\omega = 1.658$.

A second specimen from this district, exact locality unknown, possibly from the same mine, is black in the specimen and is visibly coarser grained and sparkling. This is coated along cracks with beautiful rose-red erythrite. Under the microscope it consists of quartz and tourmaline like the last. While coarser grained the tourmaline is identical in color pleochroism and refractive indices.

A specimen labeled gabbro-porphyry from the west end of the Beliel group is medium fine granular and micaceous in appearance and structure and greenish-black in color. Under the microscope the most abundant mineral is mica, apparently high-iron biotite which is practically uniaxial and negative with $\epsilon = 1.603$, $\omega = 1.655$, both $\pm .003$. It is pleochroic in plates on edge with $\omega =$ deep brownish olive-green, $\epsilon =$ pale brown, Absorption $\omega >> \epsilon$. Next in abundance is tourmaline, which is unevenly distributed in the mass of the specimen. The tourmaline is uniaxial and negative with the indices $\epsilon = 1.627$, $\omega = 1.650$. It is very pleochroic with $\epsilon =$ very pale lilac brown, $\omega =$ deep indigo to blackish-blue. Absorption $\omega >> \epsilon$. The third mineral of the aggregate is colorless and breaks into flat plates like a mica and these, when on edge, show a high birefringence. This mineral is biaxial with 2V small to medium, and a mean index of refraction, $\beta = 1.598$. It may be muscovite.

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[65] Douglas B. Sterrett. U. S. Geol. Survey, Bull. 740, pp. 86–93, 1923.

SHOSHONE COUNTY

In Shoshone County in the Coeur d'Alene district tourmaline is a microscopic constituent of the sedimentary rocks where it occurs in grains and imperfectly terminated prisms. Mr. Calkins, who has studied the occurrence of tourmaline in the area at large, regards it as a secondary constituent and not, like zircon, a mechanical inclusion in the sediments. It is never found in waterworn grains and, like siderite, it is most abundant where the rocks have been most disturbed. It does not, however, exhibit any such close relation to the monzonite intrusion as to lead to its classification as an ordinary contact-metamorphic mineral. As a rule tourmaline crystals are most numerous and best developed in the finer-grained sediments, particularly those having an abundant sericitic matrix. The coarse highly siliceous quartzites and the calcareous rocks of the Wallace formation are apparently the least favorable to the development of the mineral.[66]

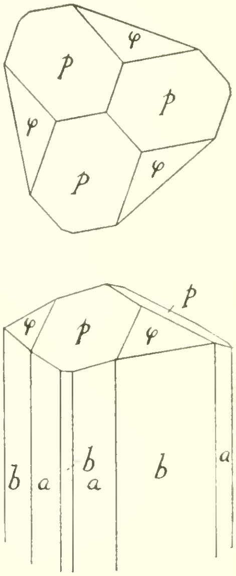

FIG. 108.—TOURMALINE. AVERY QUADRANGLE, SHOSHONE COUNTY

Ordinary black tourmaline occurs in a number of places in the Avery quadrangle in southern Shoshone County. Specimens of white anorthosite from the southeastern part of the quadrangle have crystals and rosettes of brownish black tourmaline up to 2 cm. in diameter on joints. A specimen of fine-grained quartz from a prospect at the mouth of the creek east of Bluff Creek contains scattered grains and masses of black tourmaline. A specimen labeled pegmatite from a locality 2½ miles south of Trimmed Tree consists mainly of green chlorite and feldspar with long blades of cyanite and some biotite. Embedded in the feldspar are black needles of tourmaline up to 1 cm. in length. One of these which was measured was terminated and of the habit shown in Figure 108. This gave the following angles:

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[66] F. L. Ransome and F. C. Calkins. U. S. Geol. Survey., Prof. Paper 62, p. 101, 1908.

Measurements of tourmaline, Avery Quadrangle

Form		Symbol		Quality, description	Measured		Calculated	
No.	Letter	Gdt.	Miller		φ	ρ	φ	ρ
					° ′	° ′	° ′	° ′
1	*a*	∞0	1010	Good	0 07	90 00	0 00	90 00
2	*b*	∞	1120	do	30 05	90 00	30 00	90 00
3	*p*	+1	1121	Fair	29 42	27 42	30 00	27 20
4	*φ*	−2	2241	Poor	29 49	46 27	30 00	45 47

WASHINGTON COUNTY

In the Jessie mine, ½ mile northwest of Mineral, in the Mineral district, a vein 2 to 3 feet wide consists of pyrite and chalcopyrite in a gangue of quartz and tourmaline. The vein is inclosed in diorite and carries some gold.[67]

STAUROLITE (428)

Basic iron-aluminium silicate, approximately $2FeO.5Al_2O_3.4SiO_2.H_2O$. Orthorhombic.

The only locality thus far known for staurolite in Idaho is in the southern part of the St. Joe Basin and along the St. Joe Clearwater divide as described below.

SHOSHONE COUNTY

Staurolite is strikingly developed in some of the metamorphosed rocks of the Belt series in the southern part of the Avery quadrangle in southern Shoshone County. The crystals, which reach an extreme length of 10 cm. are either twinned and cruciform or are simple and well-developed prisms. Typical specimens showing the larger twinned crystals from this locality are illustrated in Plate 9. The mineral is practically confined to a uniform bluish banded slate which has been determined by F. C. Calkins as representing the upper Wallace formation.

The crystals of staurolite are usually fresh and unaltered and have the usual brown color.

A specimen from just north of the 6,320-foot summit between Bathtub Mountain and Junction Peak (Avery quadrangle, southeast corner) contains numerous large brown untwinned staurolite crystals up to 2 by 4 cm. in size associated with a few small pink garnets in a fine micaceous base. Another specimen from the west side the knob

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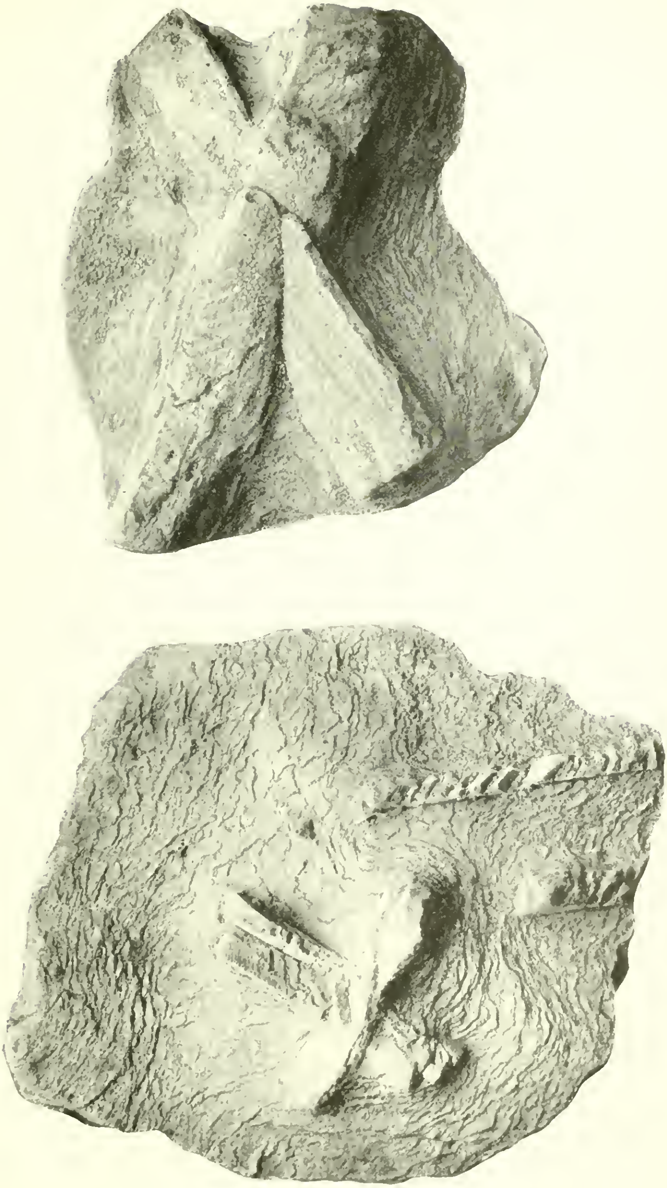
[67] Waldemar Lindgren. U. S. Geol. Survey, 22 Ann. Rept., pt. 2, p. 755, 1901.



Cruciform Crystals of Staurolite

For description of plate see page 344

about a mile north of Junction Peak shows similar and more perfect prisms of staurolite of the same size.

Specimens from ½ mile northwest of Bathtub Mountain contain numerous small cruciform twins of brown staurolite up to 1 cm. in size associated with small pink garnets and scattered large mica pseudomorphs after cyanite. Similar specimens have been collected from the summit of Bathtub Mountain.

All of the specimens seen were collected from weathered surfaces. From their nature it is evident that this area is capable of furnishing numerous excellent mineralogical specimens of this mineral.

THE ZEOLITE GROUP

The minerals known collectively as the zeolites form a group of hydrated aluminous silicates, principally of lime and soda with sometimes potash, barium, or magnesia. They are all related in composition and are similar in occurrence, but they differ widely in crystallization.

These minerals have long been regarded as the result of alteration or weathering of basic igneous rocks, an idea that has now largely been abandoned. They characteristically occur as vesicle fillings in extrusive igneous rocks or occupying veins, either in or near igneous intrusives and are probably deposited shortly following consolidation of the igneous rock as a product from the heated water given off on crystallization of the magma.

The occurrence of such minerals is probably more widespread than the following descriptions of Idaho specimens would indicate as they are not of such a character as to excite the curiosity of the prospector. Such few specimens as have been examined, with the exception of the Challis material, have been more or less chance rock specimens. The material for investigation has been unsufficient in most cases. The crystallography of the minerals is difficult, due to the imperfections of the crystals and the tendency to form complex groups and twins. Furthermore, in some species of the group the optical properties are subject to variation with variation in chemical composition not thoroughly understood and are further complicated by anomalies due to internal twinned structure, etc. In very few minerals of the group do the optical structure and the external crystallographic symmetry agree.

In the following descriptions the minerals which have been available are described as fully as the material at hand will permit. Many points remain unsettled and the localities should furnish material for additional investigation.

Several reported occurrences of zeolites in Idaho are unmentioned because no specimens have been available. A few years ago A. Albee wrote from Salmon asking whether the Smithsonian Institution would undertake to give accurate scientific identifications of zeolites from near Salmon. The Museum replied in the affirmative, but no specimens were received and letters addressed to Mr. Albee were returned. No zeolite specimens from this locality have been seen.

PTILOLITE (436)

Hydrous calcium-sodium-potassium aluminium silicate $(Ca,K_2,Na_2)O.Al_2O_3.10SiO_2.5H_2O$.	Orthorhombic.

CUSTER COUNTY

Ptilolite has been reported to occur at Challis in Custer County by Koch.[68] Later investigations on better material have resulted in the classification of this material as mordenite as fully discussed below. True ptilolite is not known to occur in the State.

MORDENITE (437)

Calcium-sodium aluminium hydrous silicate $(Ca,Na_2)O.Al_2O_3.9SiO_2.6H_2O$.	Monoclinic.

The fine cottony zeolitic mineral originally described as ptilolite from near Challis in Custer County as mentioned above has since been shown to be mordenite. A detailed study of this mineral, which has previously been published with descriptions of the associated minerals,[69] as in the main repeated below.

CUSTER COUNTY

The original specimen of the mineral from Challis was sent to the United States National Museum for identification by Milton A. Brown, of Challis, who thought it might be asbestos. A large box of specimens of the minerals from the locality was later received from Dr. C. L. Kirtley, of Challis. The mineral probably occurs in a lava flow interbedded with Miocene lake sediments south of Challis. Associated with the mordenite are heulandite, analcite, argentine calcite, quartz, chalcedony, and chlorites, all of which are described elsewhere in this report. The identification of the mineral as mordenite is the result of a careful study of the minerals of the group by Dr. Waldemar T. Schaller, who has concluded that mordenite and flokite are identical, but that the material from Wyoming which has been called mordenite is a distinct mineral (clinoptilolite) and both mordenite and clinoptilolite are distinct from ptilolite.

The mordenite seems to be present in greater abundance and in better specimens at the Idaho locality than at any other known locality for the mineral. In the lot examined it ranges from fine cottony felted aggregates through radial fibrous masses to dense

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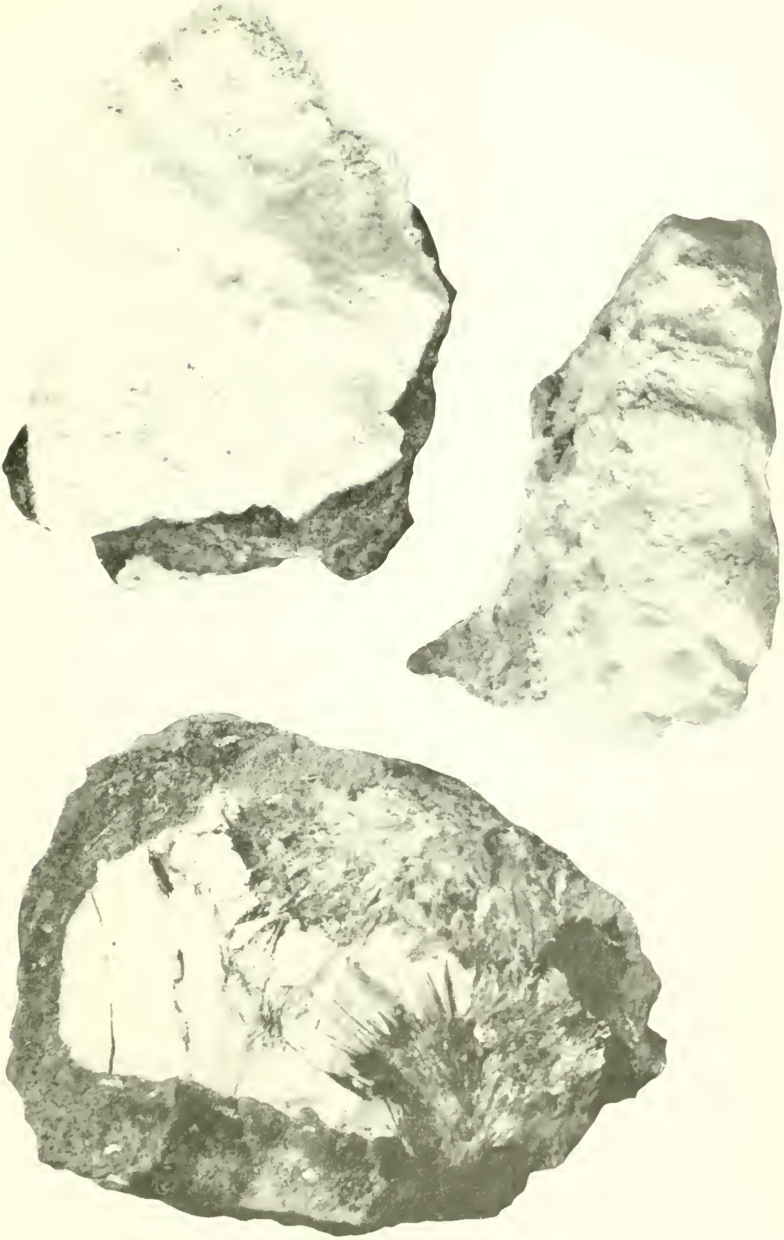
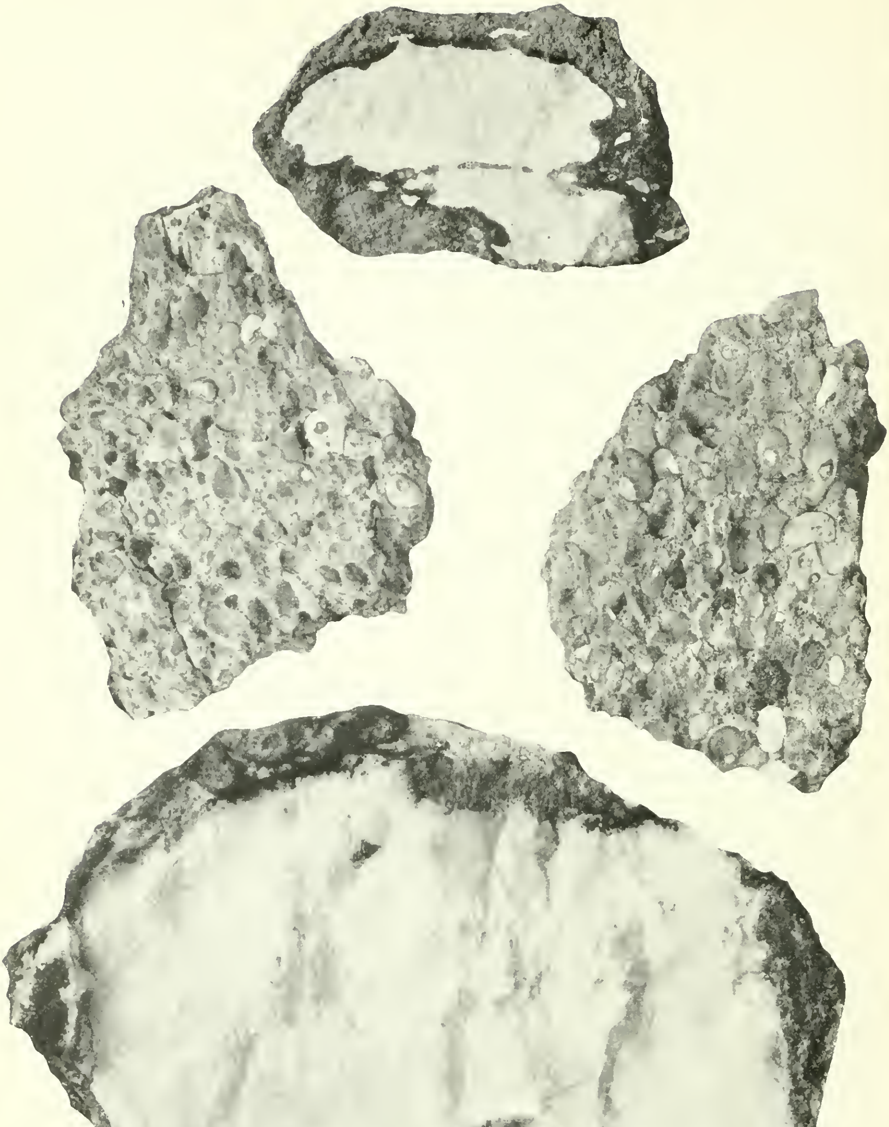
[68] Louis A. Koch. Amer. Mineralogist, vol. 2, p. 143, 1917.

[69] Mordenite and associated minerals from near Challis, Custer County, Idaho. Clarence S. Ross and Earl V. Shannon. Proc. U. S. Nat. Mus., vol. 64, art. 19, 1924.



MORDENITE, ANALCITE, AND CALCITE

FOR DESCRIPTION OF PLATE SEE PAGES 347 AND 361



Mordenite and Amygdaloid Andesite

For description of plate see pages 347 and 348

compact porcellaneous materials. Most abundant and conspicuous are the large geodal masses of fine cottony material which reach a diameter of 30 cm. or more. These vary from round to irregular in cross section and consist, usually, of a thin shell of chalcedonic material filled with the light tufted fibers of the mordenite. Although this cottony material appears entirely homogeneous to the unaided eye it all contains gritty particles which can be felt when it is crushed, and upon microscopic examination these are found to be minute spherulitic or spindle-shaped grains of quartz with radial structure. Koch selected what he thought was very pure material and estimated, after the analysis had shown an abnormal amount of silica, that the analyzed material had contained about 33 per cent of quartz. Schaller's recalculation showed that 40 per cent would be nearer the truth. The small quartz spherulites are pinned through by the mordenite fibers and have clearly developed subsequent to the mordenite. None of the fine cottony material was found to be free from quartz, although the compact varieties are frequently free from any impurity. Practically all of the geodes of the cottony type have a very thin outer shell of heulandite which forms the first lining of the cavity. Within this there is usually a thin layer of chalcedony upon which the mordenite was deposited, filling the interior of the cavity with loosely aggregated fibers. A typical specimen of this sort, although one of the smallest seen, is that illustrated in Plate 10, upper left. Many of the cavities have a thicker crust which is found upon microscopic examination to consist of chalcedony, including mordenite fibers, which have the same attitude as those which occur in the middle portion of the cavity. This chalcedony appears to be later than the mordenite and to have formed a crust by saturating the pore space of the loose textured mordenite. In some geodes of moderate size only a small area remains in the center where the mordenite is not saturated with silica, the specimen shown in Plate 11, lower, being an example while in extreme cases, noted only in the smaller masses, the entire content of the cavity has been saturated with chalcedony or, more rarely, granular quartz. One striking specimen, illustrated in Plate 12, lower, has silky bundles of short fibers of mordenite attached to masses of small quartz spherulites which project from platy (argentine) calcite. Analcite occurs as flattened crystals between the calcite plates (pl. 12, right). Both this spherulitic quartz and the calcite are probably younger than the mordenite and the calcite has apparently, in part, been dissolved away. The microscope shows the mordenite fibers of this specimen to be individually coated with thin films of calcite. In other specimens the fibers are similarly incrusted with quartz.

A part of the light cottony material which contained many of the small radial quartz grains was carefully purified by a special process and analyzed with the results given in column 1 of the table. The material of this analyzed sample was biaxial and negative with the orientation $X \wedge c = 3°40'$, $Y = a$, $Z = b$. The indices of refraction measured are $\alpha = 1.470$, $\beta = 1.475$, $\gamma = 1.475$, birefringence, 0.005.

The second sample analyzed came from a pure nodule about 8 cm. in maximum diameter which has evidently been weathered upon the surface for some time as it is weather stained, the original shell is bleached, and the mordenite is in places stained green by algae. The nodule is red on its original surface from a thin coating of heulandite succeeded inward by a thin shell of chalcedony inside which the mass consists of pure mordenite in fibers extending from all sides toward the center. The fibers are straight and close-packed and reach a maximum length of 2 cm. The color is creamy white, and the luster, on fresh fractures, is faintly silky. The analysis gave the results of column 2 of the table. The refractive indices measured on this analyzed sample are: $\alpha = 1.472$, $\beta = 1.475$, $\gamma = 1.476$, $\gamma - \alpha = 0.004$. All of the fibers which are thick enough to give appreciable birefringence show a small inclined extinction.

Many of the mordenite specimens received are amygdules free from matrix, which apparently were gathered, like so many pebbles, from the surface. These vary in size and are very irregular in form, but apparently they represent casts of the interiors of very irregular bubble cavities probably formed by the sudden expansion of steam in very viscous lava. They all preserve the original crust of red color which resembles a stain of iron oxide but which, upon more minute examination, is found to be the thin skin of heulandite which formed the first lining of the cavity. All of these heulandite-coated masses are hard and compact, but they vary somewhat in internal structure and in composition. Some of them are entirely filled with bluish chalcedony and quartz, others are mixtures of mordenite and chalcedony or mordenite and quartz, while a majority contain only pure mordenite. The mordenite of the latter varies from distinctly radial-fibrous to very compact in structure. The third analysis was made upon such a nodule which was exceedingly tough and difficult to break. Under a lens this shows a confused and interwoven fibrous structure and when examined under the microscope its structure is finely felted fibrous. The mean index of refraction, the only one determinable, is 1.473. This description applies equally well to How's original mordenite from Nova Scotia. The analysis is given in column 3 of the table.

The fourth analysis was made upon white pebble-like masses from an amygdaloid rock which is very vesicular, having half the volume occupied by small rounded cavity fillings of various colors (pl. 11, center). These include dull-green masses of scaly chlorite, flesh-red masses of heulandite, pink masses of mordenite coated thinly with heulandite, and snow-white masses of mordenite. The white masses are very compact and tough and on fracture show the texture of porcelain and are lusterless. When ground for analysis these were found to be pure with a very finely felted fibrous structure. The mean index of refraction of the material analyzed is 1.473. The analysis gave the results of column 4.

The four analyses made on the mordenites from Idaho are below stated and their average compared with the composition calculated from the formula $(Na_2, Ca) O.Al_2O_3.9SiO_2.6H_2O$, a 1 : 1 ratio between soda and lime being assumed.

Analyses of mordenite from Custer County

(Earl V. Shannon, analyst)

	(1)	(2)	(3)	(4)	Average	Theory
Silica (SiO_2)	64. 84	65. 88	67. 24	66. 25	66. 06	66. 81
Alumina (Al_2O_3)	12. 07	12. 40	12. 94	11. 88	12. 32	12. 59
Lime (CaO)	3. 08	3. 52	2. 72	2. 75	3. 02	3. 45
Magnesia (MgO)	. 26	. 48	. 28	. 44	. 36	----------
Soda (Na_2O)	3. 80	3. 52	4. 08	4. 05	3. 86	3. 83
Potash (K_2O)	. 38	. 56	. 36	. 69	. 50	----------
Water (H_2O)	14. 79	13. 40	13. 44	13. 85	13. 87	13. 32
Total	99. 22	99. 76	101. 06	99. 91	99. 99	100. 00

The analyses indicate quite conclusively that the correct formula for all of the several modifications of the Idaho mordenite is as above given. The small inclined extinction indicates that the mineral is monoclinic. Ptilolite is orthorhombic and hence gives parallel extinction. Since the fibers are very thin and the birefringence is low an extinction obliquity of several degrees might readily evade observation. Such a small angle might also be attributed to lack of adjustment between the cross hairs and the nicols of the microscope. After specially adjusting the microscope Mr. Ross found the Idaho material to give, as the mean of about 20 good measurements, an extinction inclination of 3½° measured from the elongation of the fibers.

The Idaho mordenites are interesting as furnishing a complete gradation between the physically very dissimilar compact mordenite from Nova Scotia and the cottony fibrous "flokite" from Iceland.

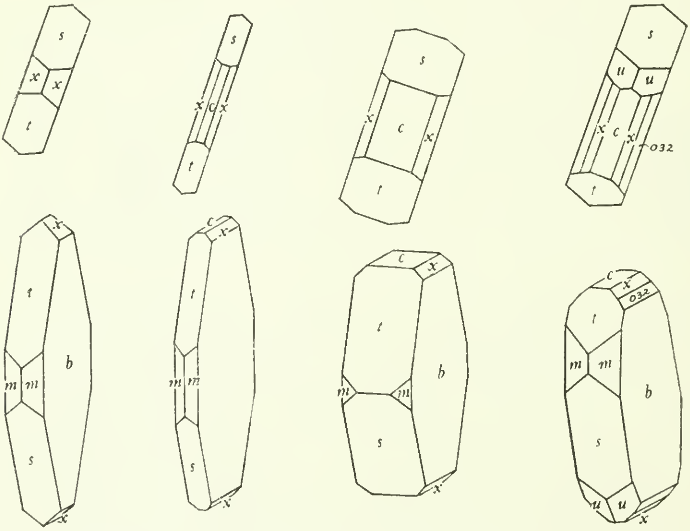
HEULANDITE (438)

Hydrous lime alumina silicate, approximately $5H_2O.CaO.Al_2O_3.6SiO_2$. Monoclinic.

Heulandite has been noted from two localities in the State, one in Adams County, in the Seven Devils district, where it occurs in very small amount with chabazite and stilbite in a contact-metamorphic ore deposit, and one in Custer County near Challis, where heulandite accompanies other zeolotes in amygdaloidal lava.

ADAMS COUNTY

Associated with chabazite and stilbite on a specimen of massive brown garnet rock from the Blue Jacket claim in the Seven Devils district are a few minute crystals of a zeolite which is probably heulandite. This mineral under the microscope shows an apparently six sided form and is strongly zoned in layers parallel to its outline and also shows some division into irregular sectors. The appearance of one of the crystals between crossed nicols is indicated in Figure 113. All sections lie on a perfect cleavage which is perpendicular to the acute bisectrix and such sections show a good interference figure which is biaxial positive with 2V medium. The β index of refraction averages about 1.50, although different zones vary considerably. The angles between the edges marked 1, 2, and 3, in Figure 113 were measured under the microscope and gave: $1 \wedge 2=65^\circ$ which corresponds to $c(001) \wedge t(101)=63^\circ\ 40'$ and $2 \wedge 3=49^\circ$ which corresponds to $180^\circ - t \wedge s(129^\circ\ 40')=50^\circ\ 20'$, so that 1 is probably *c*(001), 2 is *t*(101), and 3 is *s*(101). This makes the trace of the axial plane parallel to *c*(001) as contrasted with the heulandite from Custer County described below in which the optic plane is approximately parallel to one of the domes, either *s* or *t*.



109 110 111 112

FIGS. 109–112.—HEULANDITE. FROM CHALLIS, CUSTER COUNTY

CUSTER COUNTY

The occurrence and properties of heulandite associated with mordenite and other minerals near Challis have been fully described in a previous paper.[70] The essential features of the description are given as follows:

The heulandite occurs in the specimens both as complete fillings of small vesicles of the rock, as drusy linings of cavities, and as thin crusts forming the first lining of cavities later filled with mordenite, chalcedony, or quartz. The characteristic flesh-red masses in the amygdaloid rock consist of fine transparent heulandite and many of these small masses are hollow and present fine terminations of acute wedge-shaped crystals, the habit being as shown in Figures 109 and 110. These show very well developed cleavage parallel to the pinacoid *b*(010) as well as some other less perfect cleavages at right angles to this plane. Uusually two or several crystals are grown together in more or less parallel position, but, in the heulandite of this type, the tendency to parallel growth is not as conspicuous as usual. A majority of these pebblelike masses are not hollow but are solid masses of heulandite. Those which do show open centers often have a few fine fibers of mordenite extending across the central cavity. Other heulandite-lined vesicles in the same rock are completely filled with closely packed cottony mordenite and the faintly pink to salmon colored masses which fill may of the larger bubble cavities are compact mordenite with a thin outer skin of heulandite. The numerous irregular masses which have weathered free from the inclosing rock and which consist of compact mordenite, of mordenite saturated with quartz and chalcedony, or of quartz and chalcedony, all have a brick red outer coating which resembles a stain of ferric oxide but which, when examined with a lens, is found to consist of a thin outer crust of crystalline heulandite. All of the larger geodal masses of mordenite, of whatever type, have a thin deposit of heulandite next the inclosing rock. Optical examination of the clear crystals from hollow heulandite amygdules showed them to be transparent and devoid of any visible pigmenting material to which the red color might be attributed.

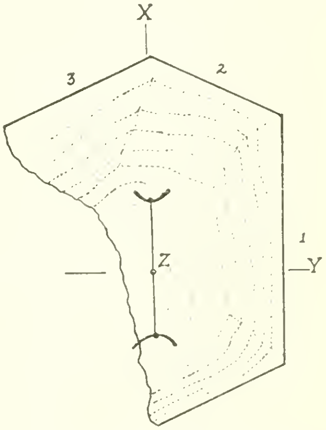


FIG. 113.—HEULANDITE. DRAWING IN POLARIZED LIGHT OF CRYSTAL LYING ON *b*(010). SEVEN DEVILS DISTRICT, ADAMS COUNTY

Optically the crystals lining the small cavities or making up the flesh red amygdules of the amygdaloid rock are biaxial positive (+)

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[70] Clarence S. Ross and Earl V. Shannon. Proc. U. S. Nat. Museum, vol. 64, Art. 19, 1924.

with 2V = 52°. The indices of refraction are $\alpha = 1.482$, $\beta = 1.485$, $\gamma = 1.489$, $\gamma - \alpha = 0.007$. The acute bisectrix (Z) is perpendicular to the *b*(010) face, while the extinction, measured from what is taken as the *c* crystallographic axis as determined by the trace of the bounding prism faces of the plates, averages 35°, the optic plane being nearly parallel (measured 5°–8°) to the trace of one of the terminal clinodomes, either *t*(101) or *s*($\bar{1}$01). The crystals, as seen between crossed nicols are frequently not entirely simple being divided by irregular sutures into areas which differ slightly in extinction angle. Thus the crystal measured and figured in the drawing (fig. 110) was found to be divided, vertically, by a straight line, on one side of which the extinction, measured from vertical cleavage lines, was 38½° while on the other side it was 44½° and a wedge entered at the termination of the crystal in which the extinction was 33°, the latter being about the normal extinction angle of homogeneous crystals. In addition to this peculiarity the crystals frequently show a very narrow outer border of a material of decidedly higher index of refraction. The crystals of this heulandite which were measured did not give very satisfactory angles, mainly because of the poor development, bulging, or parallel growth in the vertical zone rendering accurate orientation on the goniometer very difficult. The measurements are given in detail in the original paper above cited, for the crystals illustrated in Figures 109 and 110. The agreement is sufficiently close to show the essential crystallographic identity of the mineral with heulandite.

The material was anlyzed, the material for analysis being selected small red nodules and the analyzed powder was shown to be essentially pure and homogeneous by optical study. The refractive indices given above are for the analyzed powder. The analysis gave the following results and ratios:

Analysis and ratios of heulandite from Challis

(E. V. Shannon, analyst)

Constituent	Per cent	Ratios		
Silica (SiO_2)	61.14	1.014	0.145×7	1.00×7
Alumina (Al_2O_3)	14.52	.142	.142×1	.98×1
Lime (CaO)	3.60	.064	.153×1	1.05×1
Magnesia (MgO)	.28	.007		
Potash (K_2O)	.94	.010		
Soda (Na_2O)	4.48	.072		
Water (H_2O)	14.16	.787	.157×5	1.09×5
Total	99.12			

This analysis gives the formula $(Ca,K_2,Na_2)O.Al_2O_3.7SiO_2.5H_2O$. This differs from the formula for heulandite given by Dana in containing one more molecule of silica. The replacement of lime by alkalies has furthermore progressed to the point where the combined soda and potash are in excess, both molecularly and by weight, of the lime.

A form of heulandite of somewhat different properties occurs rarely in the amygdaloid rock as small solid pebble-like bodies coated on the outside with deep green chlorite and, where fractured, showing coarse granular structure, well-defined cleavage, pearly luster, and a faintly pink color. A similar material occurs as drusy crusts of brilliant crystals of faintly pink color lining small flat open cavities in the rock adjacent to the large masses of mordenite. These crystals, when examined optically, are seen, like the preceding, to be made up of sectors not identical in extinction angle, the angle between adjacent sectors varying 10° or more. Moreover they are strongly zoned, the outer zone having the following optical properties: Biaxial, positive (+), $2V=68°$, $\alpha=1.494$, $\beta=1.496$, $\gamma=1.501$, $\gamma-\alpha=0.006$, while the properties of the cores are: Biaxial positive (+), $2V=90°$, $\alpha=1.483$, $\beta=1.487$, $\gamma=1.490$, $\gamma-\alpha=0.007$. Crystallographically these are, like the others, in fair agreement with the heulandite angles, the forms identified being *b*(010), *m*(110), *c*(001), *t*(101), *s*($\bar{1}$01), *x*(011), and *w*(032). The last is a rare form previously noted only on heulandite from Scotland. In habit these pale crystals are much stouter than the others, as shown in Figures 111 and 112, and they are grown together in parallel groups over considerable areas, the plane of contact being *b*(010).

STILBITE (443)

Hydrous sodium-calcium aluminium silicate, $(Na_2,Ca)O.Al_2O_3.6SiO_2.6H_2O$. Orthorhombic.

Stilbite has been noted in specimens from Adams, Blaine, Custer, and Kootenai Counties. In two of the localities the mineral has the habit of epidesmine, but the essential identity of epidesmine and stilbite has been suggested by the writer in a previous paper.[72] Dana lists stilbite as monoclinic because of the internal twinned structure which many of the crystals show in polarized light, but Goldschmidt regards the mineral as orthorhombic and, since the crystals always show orthorhombic symmetry, the crystallization is considered orthorhombic below.

ADAMS COUNTY

Stilbite occurs with heulandite and chabazite on a specimen of massive garnet from the Blue Jacket claim in the Seven Devils district. The stilbite forms rectangular prisms and slightly divergent groups of prisms up to 2 mm. long between the chabazite crystals resting on the brown garnet. The crystals are bounded by the three pinacoids and the angles between these are 90° within the limits of error of the measurements. These simple crystals are typical "epidesmine," as illustrated in Figure 114. The broadest face here taken as the pinacoid *b*(010) exhibits a pearly luster and the best cleavage is parallel to this plane. Crystals lying on this face are homogeneous with parallel extinction. There is a less perfect cleavage parallel to (100) but the frayed ends of the fragments, when the crystals are powdered, shows that there is no basal cleavage.

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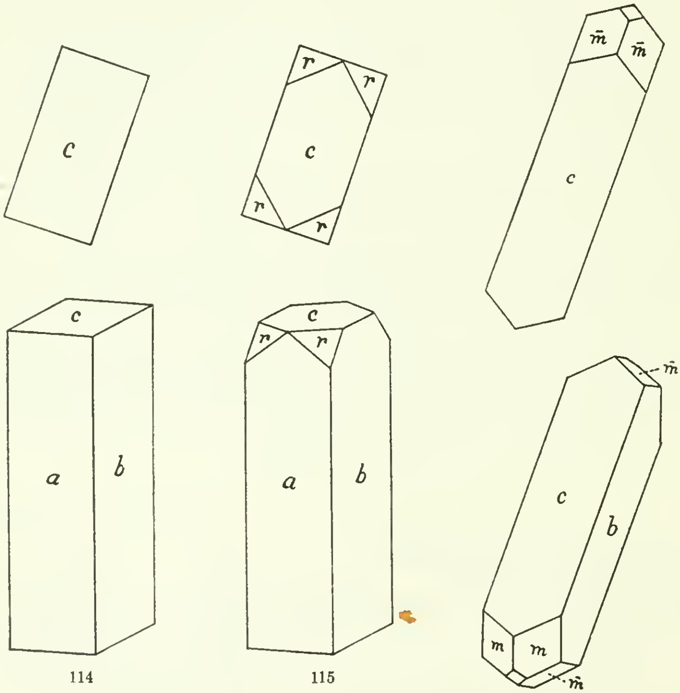
[72] Earl V. Shannon. Mineralogy and Petrography of Intrusive Triassic Diabase at Goose Creek, Loudoun County, Va. Proc. U. S. Nat. Museum vol. 66, art. 2, pp. 1-86, pls. 1-9, 1924.



114 115 116

FIGS. 114-116.—STILBITE. 114, "EPIDESMINE" HABIT FROM SEVEN DEVILS DISTRICT, ADAMS COUNTY. 115, ORDINARY HABIT DRAWN IN ORTHORHOMBIC POSITION AND LETTERED ACCORDING TO GOLDSCHMIDT, MINNIE MOORE MINE, BLAINE COUNTY. 116, MINNIE MOORE MINE, DRAWN IN MONOCLINIC POSITION AND LETTERED ACCORDING TO DANA

Sections parallel to *b*(010) show the emergence of the optic normal and all fragments lying on (010) and (100) show negative elongation, so the optical orientation referred to the figure is $X = c$, $Y = \bar{b}$, $Z = a$. Sections lying on (100) show the emergence of the obtuse bisectrix, so the mineral is optically negative, 2V medium. The refractive indices average $\alpha = 1.488$, $\beta = 1.495$, $\gamma = 1.497$, $\gamma - \alpha = 0.017$, all 0.003 (variable).

BLAINE COUNTY

Stilbite occurs in the Minnie Moore mine near Bellevue in the Wood River district, where it was identified by D. F. Hewett of the United States Geological Survey. It was found at several places in the mine, one locality being given as in fractures in shale in the footwall of the vein in the east crosscut on the 1,000-foot level. Several specimens of the mineral from this locality were examined, two of them from the Brush collection of Yale University, which were kindly loaned by Prof. William E. Ford.

The crystals are nearly colorless and transparent. They occur singly and in groups and reach a length of 3 or 4 mm. The smaller ones are the more perfect, the larger, as usual with this mineral, being made up of numerous smaller units which diverge slightly. The broad face has a pearly luster and many of them are doubly terminated. The illustrations, Figures 115 and 117, show two crystals drawn with the elongation upright, in orthorhombic position, the pearly lustered face, parallel to which the best cleavage is developed, being made the *b*(010) pinacoid. All of the crystals show the pyramidal faces conspicuously developed. The measurements obtained from the faces are not precise as they yield poor signals on the goniometer. The average of the angles measured on three crystals are given below.

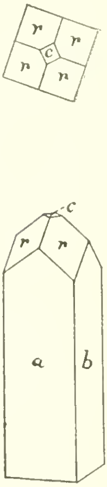


FIG. 117.—STILBITE, MINNIE MOORE MINE. CRYSTAL SIMULATING TETRAGONAL SYMMETRY. ORIENTED ACCORDING TO GOLDSCHMIDT

Measurements of stilbite, Minnie Moore mine

Form		Symbol		Quality, description	Measured		Calculated	
No.	Letter	Gdt.	Miller		φ	ρ	φ	ρ
					° ′	° ′	° ′	° ′
1	*c*	0	001	Small, poor	-- --	20 --	-- --	20 00
2	*r*	1	111	Variable, poor	44 --	48 51	42 52	48 01
3	*b*	0∞	010	Fair, pearly	0 36	90 00	0 00	90 00
4	*a*	∞0	100	Fair	89 19	90 00	90 00	90 00

In Figure 116 one of the crystals is drawn, as measured, in the position adopted for stilbite by Dana. This habit Dana considers as pseudo-orthorhombic by twinning as shown by the optical structure. The measured angles on one crystal are compared with the angles of Dana as follows:

	Measured	Dana
$m(110) \wedge m'''(1\bar{1}0)$	63° 19′	61° 10′
$c(001) \wedge a\ (100)$	51° 10′	50° 50′

This agreement, the quality of the compound faces considered, is as close as can be expected.

When the crystals are examined in polarized light lying on the *b*(010) face most of them show faint lines dividing the crystal into four quarters, by lines of apparent twinning, and the extinction of adjacent sectors is inclined 11–12° to each other and 6° to the dividing line which is parallel to the long edges of the crystals. Such crystals show the optic normal in convergent light. When the crystals are crushed they yield elongate fragments of ragged termination, showing that there is no cleavage parallel to the end face of the crystals oriented upright. Most of the fragments lie on the *b*(010) cleavage and give high birefringence colors and show the emergence of the optic normal. These are ragged in outline showing that the *a*(100) cleavage is very imperfect. Other elongate fragments which rest upon *a*(100) show the obtuse bisectrix normal to the grain. All fragments show negative elongation, so that the mineral is optically negative, 2V small. The optical orientation is $X=c$, $Y=b$, $Z=a$. The refractive indices, which seem to be variable, average about: $\alpha=1.490$, $\beta=1.503$, $\gamma=1.507$. Many of the fragments, especially those lying on (100) show a lamellar structure and rather uneven extinction, suggesting albite twinning but very irregular and confused.

Mr. Hewett regards the stilbite in this mine as having been introduced later than the ores.

CUSTER COUNTY

D. F. Hewett, of the United States Geological Survey, reports finding stilbite at Galena Summit on the north (Salmon River) side within 1,000 feet of the summit, in slabs up to 2 inches thick, in Tertiary andesite.

KOOTENAI COUNTY

Stilbite occurs with prehnite and other zeolites coating a fracture in a diabasic rock on a specimen from Post Falls, Idaho, submitted for examination by Henry Fair, of Spokane. The stilbite forms small colorless to slightly yellowish crystals lining cavities. These are rectangular and entirely like those described above from Adams County. They have the habit of typical epidesmine. When lying on the *b*(010) cleavage they show another prominent cleavage parallel to *a*(100). The mineral is optically negative, with $X=c$, $Y=b$, and $Z=a$. The *b* pinacoidal sections show the emergence of the optic normal and extinction variably inclined from 0° to 11°. The refractive indices measured are $\alpha=1.500$, $\beta=1.505$, $\gamma=1.507$, all ± 0.003.

The exact locality for the specimen is not stated, but it is said to be from a claim belonging to a man who recently caused some local interest by pretending to find rubies and diamonds at the prospect from which the zeolites came.

LAUMONTITE (445)

Hydrous lime-alumina silicate, $CaO.Al_2O_3.4SiO_2.4H_2O$. Monoclinic.

Laumontite is a member of the zeolite group, which is peculiar in that it looses a part of its water of crystallization upon exposure to air and usually turns white and disintegrates. Small amounts of this mineral have been found in Idaho in Blaine and Kootenai Counties.

BLAINE COUNTY

Specimens of laumonite were collected by D. F. Hewett of the United States Geological Survey in the Wood River district, especially at the Bellevue King prospect near Bellevue. The laumontite, which is typical in appearance, lines seams in a chloritized rock, and also occurs as veinlets up to 2 cm. thick, which are filled in the center with calcite. The crystals, which are rarely over 2 mm. in length, are prismatic with the common habit illustrated in Figure 118.

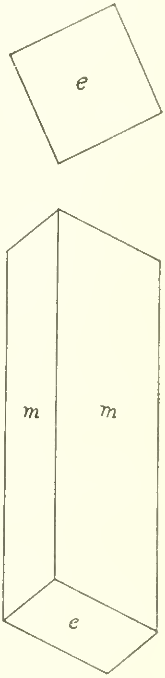


Fig. 118.—Laumontite. Common habit. Bellevue King prospect near Bellevue, Blaine County

KOOTENAI COUNTY

A few prismatic imperfect crystals of laumontite occur with stilbite, prehnite, etc., coating a fracture in diabasic rock in a specimen from Post Falls in Kootenai County.

CHABAZITE (447)

Variable hydrous silicate of lime, alkalies and alumina approximating the formula $(Ca,Na_2,K_2)O.Al_2O_3.4SiO_2.6H_2O$. Rhombohedral.

Three occurrences of zeolites which have been referred to chabazite have been examined. One of these is in a contact-metamorphic deposit in limestone and two are in cavities in lavas. The two latter have only been included under this species after much consideration and may, upon more detailed investigation than was permitted by the scanty material available, be found to be in reality some other member of the zeolite group.

ADAMS COUNTY

A specimen from the Blue Jacket claim in the Seven Devils district contains chabazite, with less stilbite and heulandite, deposited on crack and joint surfaces in massive brown garnet rock. The chabazite is the most abundant of the three zeolites of the specimen, and forms simple rhombohedral crystals, illustrated in Figure 119, of an amber-brown color averaging 2 mm. on an edge. Under the microscope the powdered chabazite shows very low birefringence. Different grains from the same crystal give both positive and negative biaxial interference figures, with 2V medium large to small. The mean refractive index varies from 1.488 to 1.490.

BOISE COUNTY

Specimens labeled as from Warm Springs Creek east of Boise, consist of very vesicular basaltic rock, containing abundant cavities up to 2 cm. in diameter largely filled with a white zeolite which is referred to chabazite.

The rock is a basalt, and contains conspicuous grains of iddingsite, the properties of which are given under that heading. The locality is given as on Warm Springs Creek, which is a tributary to Payette River from the north near the center of the Bear Valley topographic map area.

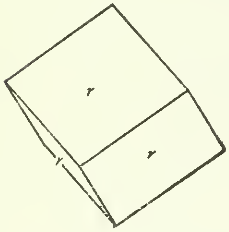


FIG. 119.—CHABAZITE. SIMPLE UNIT RHOMBOHEDRON. SEVEN DEVILS DISTRICT, ADAMS COUNTY

The zeolite forms crusts of intergrown colorless to whitish transparent to translucent crystals nearly filling many of the cavities. The crystals are not well developed and are grouped in complex twinned aggregates. When the forms are at all well defined they have a rhombohedral appearance, but no good measurements could be obtained. Some white radiated thomsonite is associated with the chabazite, and in many of the cavities there is a clayey greenish material between the chabazite and the wall of the vesicule.

Optical determinations gave varied results on material which, under a binocular microscope, appeared to all be the same. Accordingly a quantity of the material was crushed and screened and treated with heavy liquids by which process a light, an intermediate, and a heavy product were obtained.

The light product appeared homogeneous under the microscope and was transparent and colorless with uniformly low birefringence. Dim and rather unsatisfactory figures seem to show a relatively large axial angle with positive optical character, although about one grain out of each six or seven shows an apparently optically negative character. The refractive indices measured were somewhat variable but the maximum value for γ was 1.494 and the minimum for α was 1.483. Perhaps the average is $\alpha = 1.485$, $\gamma = 1.492$. Much of the material shows a lamellar structure resembling the twinning of some feldspars, but very confused and irregular. Many of the grains show rectangular or rhombic boundaries as though determined by cleavages and the persistent difficulty experienced in obtaining centered optical figures suggests cleavages inclined to the principal optical directions. This light product upon careful analysis, gave the following results:

Analysis of chabazite from Warm Springs Creek

(E. V. Shannon, analyst)

	Per cent
Silica (SiO_2)	45. 32
Alumina (Al_2O_3)	18. 84
Lime (CaO)	9. 48
Soda (Na_2O)	1. 40
Potash (K_2O)	. 72
Magnesia (MgO)	. 44
Water (H_2O) above 110° C	17. 80
Water (H_2O) below 110° C	5. 28
Total	99. 28

The intermediate separation product has about the same optical properties as the above except that the γ index of some grains is as high as 1.498 and there are numerous mixed grains of the zeolite and the clayey material.

The heavy separation product consists of the clayey mineral, needles of thomsonite and a mineral which is clear and colorless under the microscope and seems to be in rhombic grains bounded by cleavages. Lying on edge these show rectangular form, parallel extinction, high birefringence, and the emergence of the optic normal. Lying on the broadest face they are rhombic in outline, show highly inclined sweeping extinction and very low birefringence, with some blue and chocolate brown low order interference colors. On this face there is a rude division into sectors between crossed nicols. These grains in the position to show low birefringence all show a very clean cut interference figure which is biaxial positive with 2V small to medium, dispersion $r<v$ very strong. The refractive indices are $\alpha=1.505$, $\beta=1.507$, $\gamma=1.513$. Efforts to further purify this mineral with heavy solutions were not successful, as the thomsonite and a part of the clayey material had had about the same specific gravity. Treated with hydrochloric acid at boiling it is slowly decomposed leaving a silica skeleton. It is not at all certain whether this last described mineral is a variety of the chabazite or some other zeolite, such as, for example, heulandite.

ELMORE COUNTY

A specimen labeled as from Snake River lava, 5 miles below Glenns Ferry, Elmore County, consists of a vesicular lava containing considerable amounts of a crystalline white zeolite associated with a little thomsonite, overlying amber calcite. Numerous partial crystals or fragments were examined, some of which apparently were simple chabazite rhombohedra, while others had the appearance of portions of complex twins of phillipsite. The crystals, which reach 5 mm. in diameter, are intimately intergrown, poorly developed, and complexly twinned, and no reliable crystallographic measurements could be made. Optically the material seemed somewhat variable in properties and a ground and screened sample was accordingly treated with heavy solutions. Two products were thus obtained but these intergraded in specific gravity.

The lightest product which appeared homogeneous under the microscope was found to be biaxial positive with 2V small to medium, dispersion $r<v$ strong. The refractive indices are $\alpha=1.492$, $\beta=1.494$, $\gamma=1.498$, all ± 0.003 (variable). Sections perpendicular to an optic axis show no extinction in white light. Many of the grains show a confused grating structure. This purified sample was analyzed with the following results:

Analysis of chabazite (?) from Glenns Ferry

(E. V. Shannon, analyst)

	Per cent
Silica (SiO_2	46. 28
Alumina (Al_2O_3	21. 52
Lime (CaO)	8. 60
Soda (Na_2O)	. 56
Potash (K_2O)	4. 52
Water (H_2O) above 110° C	14. 52
Water (H_2O) below 110° C	4. 28
Total	100. 28

This analysis may be compared with some published analyses of high potash chabazites or it agrees equally well with many analyses of phillipsite. Neither the chemical, optical, nor crystallographic data obtained are sufficient to definitely determine whether the mineral is phillipsite or chabazite. Most of the crystals have the appearance of chabazite, but more crystallographic data, based on better specimens, is needed to finally settle the identity of this zeolite. The heavy product from the heavy-solution separation consists of the same material as the analyzed sample mixed with blades of the thomsonite described below.

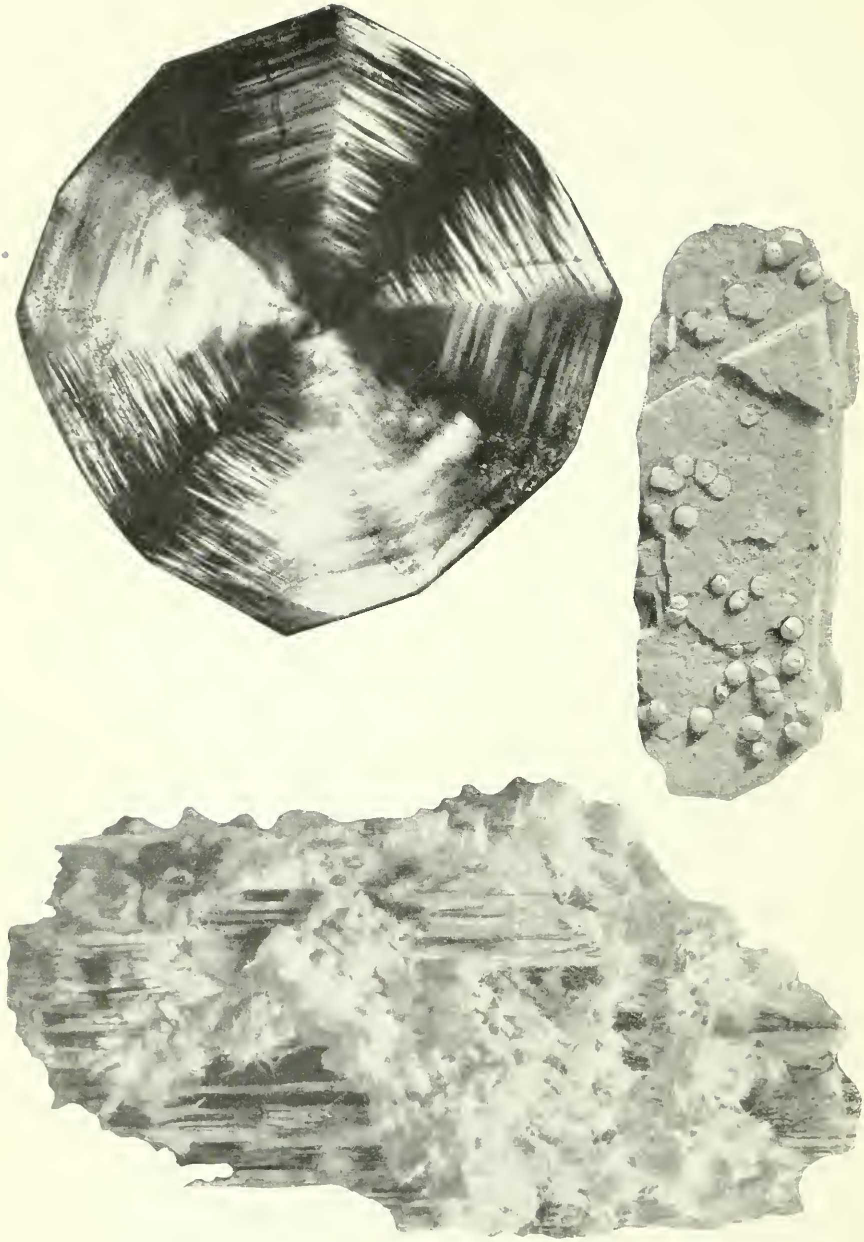
ANALCITE (450)

Hydrous soda-alumina silicate, approximating $Na_2O.Al_2O_3.4SiO_2.2H_2O$. Isometric.

Analcite is a zeolite which is isometric in crystallization, although optically it is biaxial. It has been found in Blaine and Custer Counties in Idaho.

BLAINE COUNTY

A specimen collected by D. F. Hewett from the Golden Bell mine, which is near the head of the gulch which contains the Minnie Moore mine near Bellevue in the Wood River district, contains some anal-



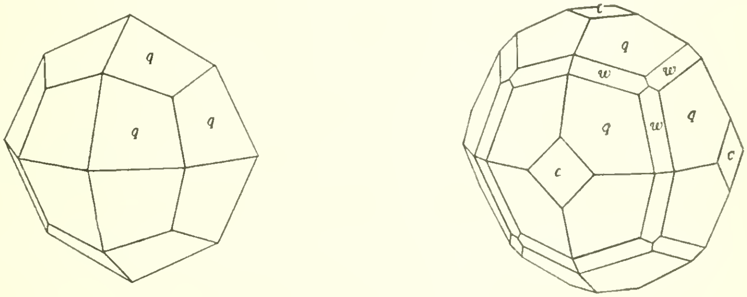
Analcite, Calcite, and Mordenite

For description of plate see pages 347 and 361

cite. The analcite occurs as transparent colorless crystals up to 2 mm. in diameter coating a fracture in a fine granitic rock.

CUSTER COUNTY

Analcite is common in association with the mordenite, described in detail above, from the locality south of Challis, as noted in a preceding paper. The analcite occurs as single crystals and groups of aggregated crystals embedded near the centers of the larger masses of cottony mordenite and as crusts and druses of crystals lining cracks in the adjacent rock or filling gashes in the mordenite which probably have resulted from solution of calcite, as shown in the upper right picture of Plate 10. Individual crystals of the analcite reach an extreme diameter of 14 mm. Where free from inclusions the analcite is clear and colorless, but the crystals commonly inclose fibers of mordenite and grains of quartz giving them a milky appearance. They are for the most part simple trapezohedrons of form $q(112)$, which is a common form for analcite as shown in Figure 120. Occasionally, however, one shows faces of the cube $a(100)$, and of the trigonal trisoctahedron $w(233)$, which though previously known are rare forms on analcite. A modified crystal is illustrated in Figure 121.



120 121

FIGS. 120–121.—ANALCITE, CHALLIS, CUSTER COUNTY. 120, SIMPLE TRAPEZOHEDRON. 121, TRAPEZOHEDRON MODIFIED BY CUBE AND TRISOCTAHEDRON

Certain very interesting crystals occur between the plates of the associated argentine calcite. These are attached to the calcite plates by the equatorial plane and, where space was available, have developed completely in their top half. Where the space between the calcite plates was thin the analcites are very much flattened and are bounded only on their edges by narrow crystal planes. Both undeformed and greatly flattened crystals are shown attached to calcite in the photograph at the right of Plate 12. These disklike plates may reach 1 cm. in diameter with a thickness of only 0.2 mm. although most of them are thicker than this, with a smaller diameter. Selected ones of these are ideal thin sections, and show admirably the birefringence and division into sectors. Such a crystal photographed in polarized light between crossed nicols is shown in Plate 12 upper. The flattened analcites adhere to the quartz films which coat the platy calcite and usually show very numerous quartz spicules attached to their surface. This quartz was ground off of the crystal shown in the photograph. Optically the analcite is biaxial and negative with large axial angle and a mean refractive index of 1.486. The biaxial interference figure is extremely sharp and definite and this, together with the geometrical perfection of the division into sectors and the sharpness of the lamellae, makes it hard to accept the idea that the mineral owes its nonisotropic character to anomalies explained by internal strain.

A sample for analysis was selected carefully and its homogeneity and purity were established microscopically. The analysis gave the following results and ratios:

Analysis and ratios of analcite from near Challis

[E. V. Shannon, analyst]

Constituent	Per cent	Ratios		
Silica (SiO_2)	57.47	0.953	0.238×4	1.19×4
Alumina (Al_2O_3)	20.85	.204	.204×1	1.03×1
Lime (CaO)	.52	.009		
Magnesia (MgO)	.21	.005		
Potash (K_2O)	.64	.007	.199×1	.98×1
Soda (Na_2O)	10.94	.177		
Water (H_2O) above 110° C	8.43	.468	.234×2	1.17×2
Water (H_2O) below 110° C	None.			
Total	99.06			

The above ratios are not satisfactorily close to whole numbers to conform to the analcite formula given by Dana, both water and silica being high. Such variations have been noted in analyses of analcite from other localities and have been variously interpreted. The mineral is somewhat variable in composition.

The paragenetic position of the analcite is late, as it grew between the laminae of calcite or occupied cavities left by removal of calcite and the analcite crystals inclosed mordenite and quartz. No other mineral is deposited on the analcite and it is probably the youngest mineral represented in the specimens from the Challis locality.

THOMSONITE (456)

Hydrous sodium-calcium aluminium silicate, $Na_2O.4CaO.5Al_2O_3.10SiO_2.12H_2O$. Orthorhombic.

Several occurrences of fibrous zeolites have been examined from Idaho localities; there has not been enough of the materials for chemical analysis and the optical determinations have not, in all cases, been satisfactory. Four occurrences are mentioned below but in two of these the mineral may not be thomsonite.

BLAINE COUNTY

A fibrous zeolite occurs in specimens from Blaine County labeled Snake River lava from Little Smoky Creek northwest of Hailey. Little Smoky Creek is shown on the Sawtooth topographic sheet. The zeolite is fine fibrous and white, radiating from the walls toward the centers of irregular filled cavities up to 8 mm. in diameter, in a dense basaltic rock.

Under the microscope this material is very finely fibrous and, so far as could be determined, has parallel extinction. Its birefringence is low and it has an opaque appearance due to air inclusions. Aggregates of fibers not quite in parallel position give an indistinct interference figure which looks biaxial and positive with 2V large. The fibers all have negative elongation which is X and not Y as they remain negative in various positions. The material is not satisfactory for measurement of the indices of refraction. The mean index is approximately 1.51. This material does not agree in optical orientation with thomsonite but it is nearer thomsonite than to other fibrous zeolites in general properties and, like the similar material from Kootenai County described below, is kept under the thomsonite heading until more is known regarding the optical properties of these minerals.

BOISE COUNTY

Associated with the chabazite from Warm Spring Creek in the Bear Valley quadrangle, is a small amount of thomsonite which occurs as round solid amygdules which are radiate fine-fibrous in structure and are white in color with a silky luster. These are much less abundant than the chabazite and usually are only about 3 mm. in diameter. A partial analysis made upon a small sample of this material gave the following results:

Partial analysis of thomsonite from Boise County

(E. V. Shannon, analyst)

Constituent	Per cent
Silica (SiO_2)	42.43
Alumina (Al_2O_3)	27.31
Lime (CaO)	Lost.
Magnesia (MgO)	1.07
Alkalies $(Na, K)_2O$	n. d.
Water above 110°C	12.85
Water below 110°C	1.28
Total	84.94

Under the microscope this material is fibrous with the elongation Y as shown when the fragments are rolled between crossed nicols under the gypsum plate. The refractive indices are about $\alpha = 1.504$, $\beta = 1.509$, $\gamma = 1.512$.

ELMORE COUNTY

Associated with the chabazite described above from 5 miles below Glenns Ferry are scattered small spherulites of a colorless mineral in radiated blades. These are only a millimeter or two in diameter and are inconspicuous. Under the microscope the mineral is in coarse flat fibers, the elongation of which is Y. The axial plane is thus across the length and the mineral is biaxial positive with 2V medium, dispersion $r<v$ perceptible. There is a perfect cleavage perpendicular to the acute bisectrix. The extinction is parallel. The refractive indices are $\alpha=1.522$, $\beta=1.525$, $\gamma=1.537$, birefringence $\gamma-\alpha=0.015$. These values are very close to those obtained for thomsonite by Wherry.

KOOTENAI COUNTY

Associated with stilbite, laumontite, prehnite, etc., on a specimen from Post Falls is a radiated fine fibrous mineral which forms centers around which stilbite occurs in parallel position continuing the fibers. Under the microscope this material is very fine fibrous with low birefringence and the grains are aggregates of fibers which give sweeping extinction. The elongation of the fibers is definitely negative and that this is X and not Y was definitely established. The birefringence is low and the extinction apparently is parallel although, in such material, a few degrees inclination would be hard to detect. The fibrous material is rendered somewhat opaque by the presence of numerous air inclusions. The determination of the indices of refraction is rendered difficult by the character of the material. The γ index was estimated in one lot at 1.518 and in another lot α was estimated at 1.505. The average for β, the mean index, is probably about 1.510.

This fibrous mineral is easily soluble in hot dilute hydrochloric acid and gelatinizes. It reacts for silica, alumina, and lime, and not for potash or barium. It fuses easily coloring the flame red and yellow.

It is obvious that the mineral described from the four localities above varies decidedly in properties, but the material is not sufficient to definitely clear up the matter of their identity. The composition of thomsonite has recently been discussed by Wherry and its optical properties by Gordon.[73] More work needs to be done to definitely clear up the optical properties of these minerals. The first, from Blaine County, has about the indices of faroelite, with elongation X. The second, from Boise County, has about the indices of mesolite, with the elongation Y as in thomsonite. The third, from Elmore County, has the indices given by Wherry for thomsonite and agrees with the data given for the optical orientation of thomsonite by Larsen. It agrees also with echellite. The fourth and last, from

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[73] Amer. Min., vol. 8, pp. 121–127, 1923.

Kootenai County, agrees in indices with faroelite but again the elongation is negative.

UNCLASSIFIED ZEOLITES

In addition to the several occurrences of zeolites noted above the following occurrences have been mentioned without more specific data than just that they are zeolites.

BLAINE COUNTY

An unidentified pearly zeolite was observed by D. F. Hewett at the Golden Bell mine at the head of Minnie Gulch near Bellevue in the Wood River district.

CUSTER COUNTY

Good specimens of zeolites have been reported from the vicinity of Salmon.

MUSCOVITE (458)

WHITE MICA, POTASH MICA

Hydrous silicate of potash and alumina, $K_2O.3Al_2O_3.6SiO_2.2H_2O$ Monoclinic.

Muscovite or white mica is a mineral of very common occurrence, especially in metamorphic rocks such as schists, etc., where it occurs in the usual small flakes and scales. In this form the mineral occurs at many places in Idaho as mica schists and micaceous quartzites as, for example, in the Archaen area about Lake Coeur d'Alene in Kootenai County, in the metamorphosed Belt rocks of southern Shoshone County, in the crystalline rocks of Mount Hyndman, and the adjacent range in the Hailey quadrangle in Blaine and Custer Counties, and in many other places in the State.

Muscovite is rare as an original constituent of unmetamorphosed igneous rocks either intrusives or lavas, and is almost invariably secondary when present in such rocks. It does occur, however, as a primary constituent of pegmatites, usually as a prominent mineral and in large crystals. These are of value when they are large enough and free from twinning and flaws, so that they may be split into thin clear sheets which are used for windows in stoves, for electrical insulation, etc. Such mica is mined to a considerable extent in Latah County as set forth below. A few of the principal occurrences of this mineral are mentioned below. Two varieties of muscovite, margarodite, and sericite, are discussed separately following the discussion of ordinary muscovite.

BLAINE COUNTY

In Blaine County muscovite occurs in scales and grains in the crystalline rocks which form the cores of the peaks about Mount Hyndman in the Hailey quadrangle and also in larger crystals in occasional pegmatites which cut some of the metamorphic rocks.

BOISE COUNTY

Muscovite occurs in crystals and flakes of moderate size in coarse pegmatitic masses and streaks in the granites of the several gold mining districts of Boise County.

CASSIA COUNTY

Mica prospects are reported to exist in Cassia County 30 miles from Albion. No details regarding them have been available.[74]

IDAHO COUNTY

Prospecting for mica is reported to have been carried on at Pardee in Idaho County.[75]

KOOTENAI COUNTY

Muscovite is abundant in the schists and gneisses of the area of supposedly Archaen rocks about Lake Coeur d'Alene and occurs occasionally in somewhat coarser crystals in pegmatitic streaks in them but nowhere, so far as known, in crystals of such size or quality as to encourage prospecting for commercial deposits.

LATAH COUNTY

The principal deposits of mica in Idaho are in Latah County, where there are a number of mines which have been worked intermittently and which have made an important total production of mica of excellent quality. The deposits lie in a belt about 2 miles wide that extends north and south for several miles in township 41 north, range 2 west, from 3 to 6 miles north of Avon. They lie at elevations of 3,400 to 4,700 feet above sea level along the top and to the west of a high mountain ridge extending south from the Thatuna Hills. The mica occurs in masses of pegmatite which cut the micaceous-schistose metamorphic rocks of the district. There are many sheets of the pegmatite, some of them outcropping for several hundreds of meters (yards). The distribution of the marketable mica is not uniform in the pegmatites and some bodies very rich in good muscovite are found. In addition to the mica, quartz, and feldspar, the pegmatites contain black tourmaline, garnet, and beryl. The principal mines of the district are the Levi Anderson, Muscovite, Morning Star, Sunshine, Maybe, and Luella.[76]

OWYHEE COUNTY

Muscovite is occasionally found in small plates and crystals in pegmatitic streaks, segregations or veins in the granite of the Silver City district.

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[74] U. S. Geol. Survey, Bull. 624, p. 119, 1917.

[75] Idem.

[76] Douglas B. Sterrett. U. S. Geol. Survey, Bull. 740, pp. 86–93, 1923.

SHOSHONE COUNTY

A few unimportant scattered pegmatitics in the southern part of the Avery quadrangle contain mica in the usual coarse plates. Much of this area is occupied by metamorphosed sedimentary rocks which contain abundant muscovite in fine flakes. In places granular pseudomorphs of muscovite after large cyanite crystals are found.

WASHINGTON COUNTY

Mica deposits have been prospected 12 miles southeast of Council near the Middle Fork of Weiser River. The specimens consist of clear mica with smooth flat cleavage and also of twinned plates having the so-called A structure. In thick pieces the mica has a dark green color. Some of it is of good quality and could be trimmed into fair sized sheets.[77]

MARGARODITE

VARIETY OF MUSCOVITE

Margarodite or pearly mica includes varieties of muscovite which are usually somewhat less elastic than ordinary muscovite and have a more pearly luster. The variety grades into ordinary muscovite and differs little from it in optical properties. Chemically it differs in having relatively less potash and more water. The place of occurrence of the margarodite is usually in quartz of veins intermediate between ordinary quartz veins and pegmatites. It is frequently associated with molybdenum and tungsten ores in such veins. Specimens of the margarodite variety of mica have been seen from two localities in Idaho as follows:

BONNER COUNTY

Pale grayish rosettes and scaly masses of the margarodite variety of muscovite occur in quartz of molybdenum ore from a molybdenite prospect 21 miles by trail southwest of Porthill, Idaho. The associated molybdenite has the same foliated and rosetted habit as the margarodite.

SHOSHONE COUNTY

Specimens from the dump of the Monitor mine in the Avery quadrangle contain scaly masses of typical margarodite associated with quartz, chalcopyrite, and carbonates.

SERICITE

VARIETY OF MUSCOVITE

While of little value as cabinet material and of unpreposessing appearance, sericite is a variety of muscovite of distinct importance to the mining geologist, prospector, and petrologist. It is commonly very fine grained with an almost or quite clayey consistency in the hand specimen and is not casually distinguishable from other clay minerals except when coarse enough to have a distinctly silky luster.

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[77] U. S. Geol. Survey, Bull. 740, p. 93, 1923.

As a rock making mineral sericite is a major constituent of many sericite or sericite-quartz schists making up the so-called hydro-mica schists and many of what have until recently been called talc schists.

Sericite is a mineral commonly formed by hydrothermal alteration of igneous rocks and occurs as a replacement of the wall rocks of many metalliferous veins, the replacement usually beginning with the feldspars and proceeding in some cases until the whole mass of the rock is composed largely of sericite. The replacement by sericite is often accompanied by the deposition of secondary silica and disseminated crystals of pyrite. Rock alteration of this type is, as a rule, not confined to the immediate vicinity of the veins, but extends outward with gradually diminishing intensity in a broad halo surrounding the center of ore-deposition and hydrothermal activity. This type of alteration is accomplished by hot alkaline waters and it is such waters which have, in most cases, deposited metalliferous ores. This is a generalization of great practical importance to geologist and prospector alike in the location of valuable ore bodies. The sericitization causes a bleaching of the rock, especially if this be a moderately coarse lava, a granitic intrusive, or a porphyry. The bleaching is accompanied by blurring and disappearance of the outlines of the original minerals, loss of coherence, assumption of a greasy or soapy feel, especially when moist, and the accession of small crystals of pyrite.

This alteration of "porphyry," which term, in western mining parlance indicates almost any igneous rock occurring in association with ore deposits, serves as a most important guide to the prospector, even though he never recognizes sericitic alteration as such. An experienced prospector will pass over miles of country with scarce a glance at the outcrops because it is, to his eye, what he describes as "hungry-looking country"—in reality because the rocks are hard and fresh. Upon entering into an area characterized by sericitic alteration he will, on the other hand, stop and search each foot of the way for metalliferous veins because, in his terms, the "rotten rock" is "likely-looking country" in which to expect metalliferous veins.

The sericitic replacement is usually especially vigorous in its attack upon the crushed rock which occupies the fissure forming the channel for the solutions and for this reason many of the so-called "clay gouges" are nearly pure sericite.

Under the microscope sericite appears as brightly polarizing scales and flakes aggregated into confused masses which often, in thin section, have a fibrous appearance. It often resembles talc, colorless serpentine, or kaolinite, from which it may, however, be distinguished by its refractive indices.

Chemically sericite has long been called hydro-mica. It is chemically and optically closely related to muscovite, but is distinguished by having less potash in many instances, and more combined water. The term also includes, petrographically, micas of the same microscopic appearance, which may contain soda and thus be properly classifiable as paragonites. Just to what extent muscovite may grade toward kaolinite is not known. Neither is it clear just what relationship exists between sericite, which contains no water which is released at a temperature of 110° C. and the "leverrierites," clayey minerals of widespread occurrence, which are similar in composition and properties but contain a varying and usually large number of molecules of water released at a low temperature. These points are further noted in the following discussion and also under the heading leverrierite below. The occurrence of sericite in several Idaho mining districts is described here.

BOISE COUNTY[78]

Throughout the Boise Ridge and Idaho Basin the primary gold veins present a certain similarity. They are all inclosed in granitic rocks or associated dikes and are all either fissure veins or impregnations connected with fissures. A marked change appears in the rock in the vicinity of the veins. The dark constituents are bleached or disappear and the feldspar is altered to a soft white opaque material, only the quartz remaining unaltered. Besides abundant pyrite, arsenopyrite also appears in small scattered crystals. This change has previously been described as kaolinization. The width of the altered zone may be from a foot up to 50 or 60 feet or more. The soft white substance which often has a greasy feel is also referred to by the miners as "talc." This change in appearance and composition is without the slightest doubt directly due to the chemical action of the solutions from which the mineral content of the vein was deposited. The process consists in a sericitization or replacement of the ferromagnesian silicates, feldspars, and part of the quartz by sericite, a fine fibrous or felted variety of muscovite, in composition a hydrous silicate of aluminium and potassium. In many places a carbonatization or replacement by carbonate of lime and magnesia goes on at the same time and sulphides, chiefly pyrite and arsenopyrite are formed in the rock as minute and perfect crystals. It is certain that this metasomatic process is a common one in fissure veins and its chemical character is very different from kaolinization. Kaolin, in fact, is a product not ordinarily found in the mineral veins and talc occurs still more rarely.

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[78] Reprinted with little change from Waldemar Lindgren. U. S. Geol. Survey, 18th Annual Report, pt. 3, pp. 638–640, 1897.

This altered granite, together with the ore or gangue occurring in seams or veins through it, constitute what the miners term a "ledge" and "ledge matter." This may be many feet wide, and the paying ore may, and in fact does usually, form only a small portion of the width of the ledge matter. The altered country rock, though often well filled with pyrite and arsenopyrite, is ordinarily very poor, containing at most $1 or $2 in gold.

While sericite has for some years been recognized as an important mineral of metalliferous ore deposits and its essential identity with muscovite has been sufficiently demonstrated, there are, in the literature very few records of thorough chemical investigation of material from metalliferous veins, especially upon samples of demonstrated homogenity and freedom from extraneous impurities. A considerable amount of excellent material being available a sample from the Carroll-Driscoll claim in Boise County was analyzed. The description, which has previously been published,[78a] is here repeated. The specimens were collected by Edward L. Jones of the United States Geological Survey, whose description has furnished the data on the occurrence of the mineral.[79]

The Carroll-Driscoll group comprises 14 claims which extend in a northeasterly direction from the end lines of the Gold Hill group to Garden Valley Pass. The property was worked in the early days and many thousand dollars' worth of gold was produced from surface workings and by sluicing disintegrated veins on the Ivanhoe and Capital claims at the head of California Gulch. The principal development work on this group consists of two tunnels, 178 feet apart, on the Ivanhoe claim. The upper tunnel, which is several hundred feet long, is now partly caved. It is a shallow drift on the vein which strikes N. 30 E and dips steeply east. Considerable ore has been produced but the amount is not definitely known. The ore consists of veinlets of massive pyrite and a little quartz which carry free gold. The country rock is granite.

The lower tunnel is driven on a course N. 60° W. for 1,450 feet. It intersects a shear zone 135 feet wide, which contains several sulphide veins in zones of more intense shearing. These veins trend from N. 30° E. to north and dip steeply east. The largest vein is near the hanging wall of the main shear zone, and its width ranges from 3 to 12 feet. The zone is further explored by a drift on its hanging wall and by short crosscuts driven to the main vein. The shear zone contains an abundant flow of water which, together with the softness of the vein matter, renders mining somewhat difficult.

[78a] Earl V. Shannon. Notes on the mineralogy of three gouge clays from precious metal veins. Proc. U. S. Nat. Mus., vol. 62, art. 15, 1922.

[79] Edward L. Jones, jr. Lode mining in the quartsburg and Grimes Pass porphyry belt, Boise Basin, Idaho. U. S. Geol. Survey, Bull. 640, p. 104, 1916.

The vein matter is composed largely of a soft white gouge which incloses the sulphides. The gouge is sericite, a secondary mica derived from the alteration of feldspars. Pyrite in well-developed crystal aggregates or individuals, is the dominant sulphide of the gouge, but here and there are fragments of older vein material in which quartz, calcite, pyrite, galena, sphalerite, and tetrahedrite were recognized. These sulphides, however, have largely been ground up and incorporated in the gouge. It is evident that there have been two general periods of sulphide deposition and that extensive alteration and movement have occurred in the vein subsequent to the first period. Pyrite is the latest mineral in the sericite gouge as proved by its well developed crystal form. According to E. F. Blain, superintendent of the property, the vein assays from $5 to $15 a ton in gold and $2 to $3 a ton in silver. No assays were made to determine whether the pyrite of the lower tunnel contains any gold and silver, but it is thought more probable that these metals are contained in the older sulphides.

The samples examined were typical specimens of the sericite gouge from the shear zone and consist in the main of the fine scaly sericite containing disseminated crystals of pyrite up to 1 cm. in diameter. One of the larger specimens contained a mass of quartz and sulphides of the first mineralization and this was examined after the adhering sericite had been removed by scrubbing with a brush and water. The mass is a nodule of white quartz, rounded as though by corrosion, containing pyrite, galena, tetrahedrite, and a colorless to light resin or greenish-yellow sphalerite in well-formed crystals up to 1 cm. in diameter. There is also a little of a mineral of grayish purple color and well-defined cleavage which agrees in optical properties and blowpipe reactions with barite.

In the hand specimen the sericite is visibly micaceous with a very finely foliated structure and distinctly silky luster. The color varies from cream or dirty white to pale greenish. When moist it is plastic with a greasy feel. The optical properties were carefully determined by Clarence S. Ross, of the United States Geological Survey, and are given in column 1 below, while in column 2 are given, for comparison, the properties of normal muscovite quoted by Larsen.

Comparison of optical properties of sericite and muscovite

(1) Sericite (Ross)	(2) Muscovite (Larsen)
Biaxial.	Biaxial.
Negative (−).	Negative (−).
2V=25°.	2V=40°.
X=*c*.	X=*c*.
Indices:	Indices:
$\alpha=1.550\pm0.003$.	$\alpha=1.561$.
$\beta=1.585$ .003.	$\beta=1.590$.
$\gamma=1.587$ .003.	$\gamma=1.594$.
Birefringence 0.037.	Birefringence 0.033.

While the indices are slightly lower and the birefringence a little higher, the optical properties are not greatly different from those of ordinary muscovite.

Heated before the blowpipe the sericite fuses on the edges to a white enamel. This property is important since muscovite and kaolinite are commonly listed as infusible minerals and leverrierite has heretofore been separated from these minerals on the basis of its fusibility. Heated in the closed tube the mineral first darkens and then becomes white again and yields water having an acid reaction.

Optical examination of the material which had been selected for analysis showed it to be essentially homogeneous except for the presence of two minerals in small amount, one certainly colorless zircon in minute crystals and the other an isotropic mineral in colorless grains of high refractive index, quite probably the light-colored sphalerite mentioned above. These were entirely removed by a method of selective crushing and screening. A screen was selected with meshes smaller than a majority of the sericite flakes and the material was screened repeatedly, alternating the screening with rolling the powder, spread thinly on plate glass, with a hardened steel rod. The brittle impurities were thus crushed so as to pass the screen while the micaceous sericite remained behind. Even before purification the impurities amounted to only a fraction of 1 per cent. Upon analysis this purified sample gave the following results and ratios:

Analysis and ratios of sericite from Carroll-Driscoll mine

(E. V. Shannon, analyst)

	Per cent	Ratios			
Silica (SiO_2)	46.58	0.773	0.773	0.387×2	1.00×2
Alumina (Al_2O_3)	37.46	.367	.371	.361×1	.96×1
Ferric iron (Fe_2O_3)	.80	.005			
Lime (CaO	Trace.				
Magnesia (MgO)	1.16	.029	.443	.443×1	1.15×1
Potash (K_2O)	6.38	.068			
Soda (Na_2O)	.64	.010			
Water (H_2O) above 110° C	6.06	.336			
Water (H_2O) below 110° C	.30				
Total	99.38				

Compared with published analyses, the above, like most analyses of sericite and related secondary muscovites, is low in potash and correspondingly high in water. The molecular ratio of water to total alkalies is 3½ to 1 instead of 2 to 1, as in the formula given above for muscovite. The very low content of low-temperature water is noteworthy.

Sericite, as indicated above is abundant in connection with practically all of the veins of Boise County. A number of specimens have been seen, among which the following may be mentioned:

Specimens of ore from the Enterprise vein, Blackbird tunnel, Diana Mines Co., Pioneerville district, consist of cream-white silky sericite which is the gangue of pyrite and sphalerite, and a specimen from the stope below the tunnel level of the Golden Age mine, in the same district shows much sericite replacing the granite adjacent to quartz containing sulphides.

Typical silky sericite occurs in small amount coating one side of a specimen of heavy sulphide ore from altered granite porphyry from the Coon Dog No. 4 mine. Silky brownish iron-stained sericite coats fractures in quartz of high grade ore from the Lucky Boy mine, Idaho City district. In a specimen from the Lincoln mine, Pearl district, silky sericite occupies cavities in masses of dark brown sphalerite.

CUSTER COUNTY

In Custer County sericite is meagerly developed in the Alder Creek district. It has been detected in specimens of the granite-porphyry only from the vicinity of the Iron Tunnel. In trachyte-porphyry dikes it is abundantly developed after orthoclase.[80]

LEMHI COUNTY

In Lemhi County, although sericite is probably widespread in occurrence, it has been noted only in specimens from the Indian Creek, Mineral Hill, Mackinaw, and Parker Mountain districts. In the latter district it occurs both in the quartz of the veins and in the wall rock adjacent thereto. In the quartz it is probably, in part at least, derived from adularia. It invariably occurs as foils and shreds of microscopic size.[81]

OWYHEE COUNTY

Sericitization of the walls of veins and adjacent rocks is a pronounced feature in the Silver City and other silver and gold mining districts of Owyhee County as pointed out by Lindgren,[82] Lindgren found that the abundant white clay which accompanies the ores of the Silver City and other districts varied in composition, in some cases having the composition of pure sericite, in others of pure kaolinite, and in others of mixtures of the two. A specimen of clay from the Garfield tunnel at Silver City which contained abundant marcasite in arborescent forms proved upon analysis to correspond in composition to a mixture of kaolinite and sericite. A "talc" clay filling fissures in the Henrietta mine and rich in miargyrite proved to have a similar composition. The Ontario vein on Florida Mountain contains much thin white clayey material. A specimen from the tunnel 610 feet from the portal contained:

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[80] J. B. Umpleby. U. S. Geol. Survey, Prof. Paper 97, p. 54, 1917.

[81] J. B. Umpleby. U. S. Geol. Survey, Bull. 528, p. 79, 1913.

[82] Waldemar Lindgren. U. S. Geol. Survey 20th, Ann. Rept., pt. 3, p. 640, 1900.

	Per cent
Water (H_2O) below 100° C	0. 33
Water (H_2O) above 100° C	2. 75
Potash (K_2O)	12. 91
Soda (Na_2O)	. 35

This, which neither to the naked eye nor by the microscope can be distinguished from kaolinite is clearly a nearly pure muscovite. The Tip Top vein in the drift 70 feet down from the collar of the shaft, consists of 4 feet of light brownish "talcose" clay which contains:

	Per cent
Water (H_2O) below 100° C	0. 82
Water (H_2O) above 100° C	3. 38
Potash (K_2O)	11. 98
Soda (Na_2O)	. 34

This also is evidently nearly pure sericite. A 4-inch seam of light-gray clay from the hanging wall of the same vein contained:

	Per cent
Water (H_2O) below 100° C	5. 53
Water (H_2O) above 100° C	10. 04
Potash (K_2O)	3. 21
Soda (Na_2O)	. 18

This latter corresponds to a mixture of sericite and kaolin.

Guided by the above partial analyses, which were made by Hillebrand, Lindgren classified the clays as sericite or as mixtures of sericite and kaolinite on the basis of alkali content. This means does not consider the extent to which the potash, essential to muscovite proper, may be replaced by water in sericite. By this rule the sericite described as analyzed from Boise County, which contains only 6.38 per cent of potash and 6.06 per cent of water, as compared with the 11.8 per cent of potash required for the muscovite formula, would be classified as such a mixture of muscovite and kaolinite. Its homogeneity, in the analyzed sample, is unquestionable. The same may be true of the clays from Owyhee County, which have been considered as mixtures. One of the supposed mixtures of kaolinite and sericite from the Silver City region has been reexamined by the writer and the description has been published in the paper on gouge clays above cited. This is the clay associated with arborescent marcasite from the Garfield tunnel. This was analyzed with the following results:

Analysis and ratios of clay from Garfield tunnel

(E. V. Shannon, analyst)

	Per cent	Ratios		
Silica (SiO_2)	45.94	0.762	0.762	1.00×5
Alumina (Al_2O_3)	34.14	.334	.342	1.12×2
Ferric iron (Fe_2O_3)	1.26	.008		
Lime (CaO)	.84	.015	.480	1.05×3
Magnesia (MgO)	.18	.004		
Potash (K_2O)	6.52	.069		
Soda (Na_2O)	.18	.003		
Water (H_2O) above 110° C	7.00	.389		
Water (H_2O) below 110° C	2.70	.150	.150	1.00×1
Total	98.76			

The formula derived from this analysis is—

$$3(H,K)_2O.2Al_2O_3.5SiO_2.H_2O$$

which is indeed like the composition which might be obtained from a mixture of muscovite and kaolinite. It is also similar to the composition obtained for the sericite from Boise County except in that the alumina is low and there is one molecule of water which is lost at 110° C. Optically the material is nearer leverrierite with the indices of refraction approximately $\alpha = 1.547$, $\gamma = 1.556$, birefringence 0.009. It is so exceedingly fine grained that it is not possible to say definitely that there is no amorphous material mixed with the minute crystalline flakes but the material all appears of the same refractive index and birefringence which is lower than for either muscovite or kaolinite. The evidence seems to be in favor of the conclusion that these clays are not so simple as just mixtures of kaolinite and sericite. Many of them may be pure sericite, even when low in potash, while others may be more properly classifiable as leverrierite, a mineral of similar properties whose exact relation to the muscovite and kaolinite groups is not yet known. These clays are further discussed under the headings leverrierite and kaolinite below.

SHOSHONE COUNTY

In Shoshone County extensive formations of quartzitic or slaty rocks are characterized by the more or less abundant occurrence of sericite throughout. The Burke formation is characteristically a slaty sericitic quartzite and the Wallace formation is, in places, practically a sericite slate or schist. The occurrence of this sericite is regional and its formation long antedates the deposition of the ores, and is in no way connected with them. A small amount of sericitization occurred during the period of vein-forming activity, but this consisted mainly of the conversion to sericite of crushed material along fissures. The so-called talc of the gouges of fissures in the vicinity of the orebodies consists for the most part of sericite.[83]

BIOTITE (462)

BLACK MICA, IRON MICA

Variable hydrous silicate of magnesia, iron, alumina, etc., usually approximating the formula $(H,K)_2O.2(Mg, Fe)O.Al_2O_3.3SiO_2$.	Monoclinic.

Biotite is similar in distribution and occurrence to the corresponding white mica or muscovite. It occurs similarly in schists and gneisses and is much more frequent as an original constituent of igneous rocks, both acidic and basic. Like muscovite, biotite is frequently found in larger plates and crystals in pegmatites, although no such occurrence in Idaho pegmatites has yet been brought to notice. A number of occurrences are noted below, most of them rather because they have been examined in the course of studying associated minerals than because they possess unusual features.

CUSTER COUNTY

Biotite occurs as an original constituent of the granite-porphyry of the Alder Creek district. During endomorphism it has changed to diopside.[84]

LATAH COUNTY

In the Mizpah mine, Hoodoo district, biotite occurs abundantly as isolated coarse crystals distributed through the solid chalcopyrite and pyrrhotite of the ore.[85]

LEMHI COUNTY

Biotite is developed in beautiful rosettes in some of the cobalt ores of the Blackbird district, notably those of the Togo claim.[86] A specimen from this district collected by Frank L. Hess of the United States Geological Survey, the exact locality for which is not known, consists of large blades of biotite in an indeterminate serpentinous matrix. The biotite blades reach a size of 6 by 2 cm. They are dark-greenish brown in color and each blade is divided, centrally, by a vertical line on each side of which are inclined striations giving a feathery appearance.

A specimen of medium fine granular biotite from the west end of the Beliel group has been mentioned above as containing tourmaline. Under the microscope this is practically uniaxial and negative with $\epsilon=1.603$, and $\omega=1.655$, both ± 0.003. Plates on edge show pleochroism with ω = deep brownish olive-green, ϵ = pale brown. Absorption $\omega >> \epsilon$. Associated with the biotite of this specimen is some muscovite as well as a considerable amount of tourmaline in microscopic crystals.

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[83] F. L. Ransome and F. C. Calkins. U. S. Geol. Survey, Prof. Paper 62, 1908.

[84] J. B. Umpleby. U. S. Geol. Survey, Prof. Paper 97, p. 50, 1917.

[85] D. C. Livingston and F. B. Laney. Idaho Bur. Geol. and Mines, Bull. 1, pp. 95-96, 1920.

[86] J. B. Umpleby. U. S. Geol. Survey, Bull. 528, p. 75, 1913.

SHOSHONE COUNTY

A peculiar green biotite occurs in microscopic grains in the ores of the Success and other mines surrounding the monzonite area of Ninemile Creek.[87] Biotite occurs in golden brown to black scales up to 1 cm. in diameter and often with sharp hexagonal outlines. in lamprophyric rocks at several places in the district.[88] In the metamorphic rocks in the southern part of the county, particularly in the area included in the southern part of the Avery quadrangle, biotite is a common product of the metamorphism of the Belt sedimentary rocks, both in the form of schists containing coarse flakes of biotite and as fine purplish hornfels which consist largely of microscopic biotite. Such rocks, derived by the metamorphism of the Wallace formation, have been described as containing hornblende and scapolite. Bordering many small pegmatitic intrusions and larger granitic dikes in the biotitic metamorphic rocks there appear considerable layers of biotite in schistose aggregates of coarse brown to black plates.

CHLORITOID (466)

BRITTLE MICA, MASONITE

Hydrous silicate of magnesia, lime, iron, alumina, etc., approximating the formula: $(Mg,Ca)O.Al_2O_3.SiO_2.H_2O$. Monoclinic.

Chloritoid is a relatively uncommon mineral, like the other members of its group. It is the only one of the so-called brittle-mica minerals thus far found in Idaho.

LEMHI COUNTY

Chloritoid occurs as the principal constituent of a lot of material which, according to the label, is typical of a contact-metamorphic mass occurring on the hanging wall side of a dike about 10 feet wide on the Nickel Plate and the adjoining property in the Blackbird district.

In the hand specimen this material is coarse granular and dark grayish-green in color and is made up of interlocking crystals of the chloritoid averaging a little less than 1 cm. in diamteer. Associated with the chloritoid are variable amounts of a green chlorite and colorless muscovite. The chlorite is described below.

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[87] F. L. Ransome. U. S. Geol. Survey, Prof. Paper 62, p. 101, 1908.

[88] Earl V. Shannon. Petrography of some lamprophyric dike rocks of the Coeur d'Alene mining district, Idaho. Proc. U. S. National Museum, vol. 57, pp.475–495, 1920.

In thin section under the microscope the chloritoid appears to be the earliest mineral of the aggregate and this has been shattered and the chlorite and muscovite have filled the fractures.

Optically the chloritoid is well characterized by its intense pleochroism. It is biaxial positive with 2V small to medium dispersion $r > v$ very strong, crossed dispersion strong. The refractive indices are approximately $\alpha = 1.720$, $\beta = 1.722$, $\gamma = 1.731$, birefringence $= 0.011$. The optical orientation is $X = b$, $Z \wedge c = 18°$ to $21°$. Pleochroism: X = colorless to pale greenish-brown, Y = indigo blue, Z = pale brownish-green. Absorption $Y > Z > X$.

The material was separated from the associated chlorite and muscovite for analysis by means of heavy solutions and the electromagnet. This was analyzed but the analysis was not extremely accurate since it was found that the sample contained about 3 per cent of cobaltiferous arsenopyrite present as the very finely disseminated dust-like grains and not discovered until the analysis was well advanced. After correcting as well as possible for this arsenopyrite, the analysis, recalculated to 100 per cent, gave the following results and ratios:

Analysis (corrected) and ratios of chloritoid

(E. V. Shannon, analyst)

	Per cent	Ratios		
Silica (SiO_2)	22.67	0.376	0.376×1	0.95×1
Alumina (Al_2O_3)	38.86	.380	.399×1	1.00×1
Ferric iron (Fe_2O_3)	2.98	.019		
Ferrous iron (FeO)	25.46	.354	.420×1	1.05×1
Lime (CaO)	.93	.017		
Magnesia (MgO)	1.96	.049		
Water (H_2O)	7.14	.396	.396×1	1.00×1
Total	100.00			

The analysis approximates rather closely to the simple formula $FeO.Al_2O_3.SiO_2.H_2O$.

It is evident that the chloritoid must be present in large amount at the Idaho locality and, in view of the rarity of the mineral, specimens should be of considerable interest to collectors.

THE CHLORITE GROUP

The chlorites include a large number of named species whose exact relations to one another are not well understood. It is one of the least known of the natural mineral groups and it is often very difficult to decide where, among the several species, to classify a given specimen, even when a complete analysis and optical measurements have been obtained. The minerals of the group are hydrous silicates of ferrous and ferric iron, alumina, and magnesia. In composition and structure they are related to the micas and they almost invariably possess a coarse or fine micaceous structure. A majority of the members of the group are characterized by a green color.

The following chlorites from Idaho localities have been classified as accurately as possible from the data available, but many of the identifications are but tentative. Few of the examinations could be completed on account of scarcity of material.

ADAMS COUNTY

Chlorite is listed, without further description, by Livingston and Laney, as occurring in the contact-metamorphic copper deposits in limestone in the Seven Devils district.[89]

CUSTER COUNTY

A few small specimens from the Basin group, a prospect on the Custer County side of the divide at the head of Trail Creek in the Hailey quadrangle, mentioned under garnet, prehnite, etc., contain scaly aggregates of minute greenish-brown folia associated with garnet and epidote. Under the microscope this material appears as brown fibrous shreds which are nonpleochroic and have a mean refractive index of about 1.65. This mineral has the appearance of chalcodite which is an altered variety of the chlorite stilpnomelane.

In specimens of mordenite and other zeolites from near Challis, in Custer County, which have been described in a previous paper[90] and which have been mentioned above under mordenite and heulandite, about one-fourth of the total number of pebble-like fillings in an amygdaloid rock consist of a soft brownish-green chlorite. The other amygdules are filled with mordenite and heulandite. This chlorite does not occur in the same vesicles with any of the zeolitic minerals, but it is sparingly distributed in the silicified portions of the inclosing rock adjacent to some of the large zeolite-filled cavities.

The small chlorite fillings which reach an extreme diameter of about 7 mm. are easily freed from the surrounding matrix and, when crushed, yield a homogeneous sample for analysis. Under the microscope the chlorite is seen to consist of yellow-green irregular folia. These are biaxial and optically negative (−) with 2V around 15°. The indices of refraction, which are high for a chlorite, are $\alpha = 1.615$, $\beta = 1.637$, $\gamma = 1.638$, birefringence $\gamma - \alpha = 0.023$. The mineral is strongly pleochroic with X and Y olive-green and Z brownish yellow. This material was analyzed, yielding the following results and ratios:

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[89] D. C. Livingston and F. B. Laney. Idaho Bur. Mines and Geol., Bull. 1, p. 62, 1920.

[90] See under mordenite.

Analysis and ratios of chlorite from near Challis

(E. V. Shannon, analyst)

	Per cent	Ratios.		
Silica (SiO_2)	30.76	0.510	0.170×3	1.00×3
Alumina (Al_2O_3)	12.12	.119	.176×1	1.03×1
Ferric iron (Fe_2O_3)	9.12	.057		
Ferrous iron (FeO)	22.76	.317	.160×4	.94×4
Manganous oxide (MnO)	1.24	.018		
Lime (CaO)	Trace.	------		
Magnesia (MgO)	12.36	.307		
Water (H_2O) above 110° C	9.76	.542	.160×4	.94×4
Water (H_2O) below 110° C	1.80	.100		
Total	99.92			

This analysis yields the formula $4(Fe,Mg)O.(Al,Fe)_2O_3.3SiO_2.4H_2O$. With $FeO:Mg=1:1$ and $Fe_2O_3 : Al_2O_3=1:2$. This can not be definitely assigned to any member of the chlorite group, but is most closely related to diabantite and delessite, chlorites occurring characteristically as amygdule fillings in basic igneous rocks. The high content of ferric iron may in part be secondary and due to oxidation of a part of the iron originally present as ferrous oxide.

Heated in the forceps before the blowpipe this chlorite exfoliates somewhat, becomes magnetic, and finally fuses with some difficulty to a black magnetic slag. In the closed tube it yields abundant water having an acid reaction, indicating a small fluorine content. It is quickly and completely soluble in hot 1:1 hydrochloric acid.

In the same specimens there occurs a second chlorite which never completely fills the cavities but merely forms a thin lining 0.5 mm. or less in thickness in cavities containing fillings of mordenite and serves as a coloring matter in the surrounding andesite. It is impossible to obtain enough of this material in pure form for analysis. It is deep blue-green in the specimen and under the microscope is seen to consist of finely felted shreds and scales of a deep blue-green color which, in the aggregate, do not show any noticeable pleochroism. The indices of refraction are $\alpha=1.606$, $\gamma=1.608$, birefringence $\gamma-\alpha=0.002$. This chlorite differs from the preceding both in color and birefringence.

LEMHI COUNTY

Green micaceous rosettes associated with apatite in porous schist in the cobalt ores of the Togo property, in the Blackbird district, consist of a chlorite which is biaxial and positive with 2V nearly 0°. The acute bisectrix is normal to the basal plates and the refractive index, β is is about 1.620. The mineral is pleochroic with X and Y blue-green and Z greenish brown. This chlorite is not appreciably decomposed by boiling with 1:1 hydrochloric acid.

The specimens consisting largely of chloritoid from the Nickel Plate property, in the Blackbird district, which have been described above under chloritoid, contain a considerable amount of a green chlorite. This chlorite is biaxial and negative with 2V nearly 0°. The refractive indices are $\alpha = 1.650$, β and $\gamma = 1.660$. The pleochroism is X = pale brown, Y and Z = green. The chlorite was separated for analysis from the chloritoid and the associated muscovite by means of an electromagnet and heavy solutions. This was analyzed but the presence of several per cent of cobaltiferous arsenopyrite in dusted very minute grains in the sample was not suspected and the analysis was somewhat upset by its presence, as in the case of the chloritoid. After being corrected as well as possible for the several errors arising from this cause, it was recalculated to 100 per cent, yielding the following results and ratios:

Analysis (recalculated) and ratios of chlorite

[E. V. Shannon, analyst]

	Per cent	Ratios		
Silica (SiO_2)	21.93	0.364	0.121×3	1.03×3
Alumina (Al_2O_3)	23.53	.230	.115×2	.98×2
Ferric iron (Fe_2O_3)	Trace.			
Ferrous iron (FeO)	37.38	.520	.113×6	.97×6
Magnesia (MgO)	6.28	.156		
Water (H_2O)	10.88	.604	.121×5	1.03×5
Total	100.00			

These ratios yield the formula $6(Fe,Mg)O.2Al_2O_3.3SiO_2.5H_2O$. This chemically is very similar to some prochlorites. The formula is identical with that obtained for an analysis of corundophilite from Chester, Mass. The optical properties, both the optical character and the high refractive indices, are different from most of the minerals of the group.

SHOSHONE COUNTY

A specimen labeled pegmatite from 2½ miles south of Trimmed Tree Hill in the Avery quadrangle consists mainly of feldspar and chlorite with less cyanite, tourmaline, and biotite. The chlorite is dull green and coarsely foliated in the hand specimen. Under the microscope it is biaxial positive with 2V approaching zero, acute bisectrix perpendicular to the plates. The color is so pale that the pleochroism in tones of brownish green and brownish blue-green is not marked. The refractive indices, α and β are 1.595 ± 0.003. This chlorite is probably intermediate between clinochlore and amesite, approaching the latter.

A specimen from the Sherman mine on Pine Creek contains a very fine scaly deep green chlorite surrounding ankerite rhombohedra up to 2 cm. on an edge or replacing fragments of gray quartzite included in the quartz of the vein. Other minerals associated with the chlorite are pyrite and pyrrhotite which apparently are later. Under the microscope the chlorite is very fine granular with very low birefringence. It is apparently biaxial negative with 2V nearly 0°. The pleochroism is not marked, X pale brownish green, Y and Z bluish green. The α, β, and γ indices are about 1.640 to 1.645. Only a small amount of the chlorite could be separated for analysis and there was not enough of the material to permit determination of the state of oxidation of the iron. Assuming it to all be ferrous, the analysis gave and following results and ratios:

Analysis and ratios of chlorite from Sherman mine

[E. V. Shannon, analyst]

	Per cent	Ratios			
Silica (SiO_2)	21.56	0.360	0.360	0.120×3	1.02×3
Alumina (Al_2O_3)	20.44	.200	.200	.100×2	.85×2
Ferrous iron (FeO)	39.40	.548	.763	.127×6	1.09×6
Lime (CaO)	Trace.	----			
Magnesia (MgO)	8.62	.215			
Water (H_2O)	9.88	.549	.549	.110×5	.94×5
Total	99.90				

This analysis leads to the formula $6(Fe,Mg)O.2Al_2O_3.3SiO_2.5H_2O$, or precisely that derived for the chlorite associated with the chloritoid from Lemhi County, described above, and the correspondence in optical properties is close enough to establish the practical identity of the chlorites from these two localities.

A similar chlorite occurs as fine granular streaks associated with ferriferous calcite, quartz, and chalcopyrite in a specimen of ore from the Blackbear prospect in the Avery quadrangle. The chlorite has been mentioned in connection with the calcite, an analysis of which is given above under that heading.

Under the microscope this chlorite is pleochroic in X and Y deep green, Z = greenish brown. It has low birefringence and gives no very definite interference figures but is apparently biaxial and positive with 2V very small. The refractive indices are approximately $\alpha = \beta = 1.630$, $\gamma = 1.635$. A very small sample was analyzed giving a very inferior analysis in which the magnesia was lost through accident and had to be taken by difference. The ferrous iron reported was actually determined to be present as such, but total iron was not estimated and the alumina may include a little ferric iron. The analysis gave the following results and ratios:

Analysis and ratios of chlorite, Black Bear claim

(E. V. Shannon, analyst)

	Per cent	Ratios			
Silica (SiO_2)	24.80	0.413	0.413	0.083×5	1.03×5
Alumina (Al_2O_3)	22.86	.225	.225	.075×3	.93×3
Ferrous iron (FeO)	28.72	.400	.737	.082×9	1.01×9
Magnesia (MgO)	(13.48)	.337			
Water (H_2O)	10.14	.563	.563	.080×7	.99×7
Total	100.00				

This analysis may be compared with many analyses of prochlorite given by Dana. The formula yielded by the ratios is 9 (Mg,Fe) $O.3Al_2O_3.5SiO_2.7H_2O$.

Other similar occurrences of fine-grained chlorites have been noted in other veins in the Coeur d'Alene region. They are nowhere conspicuous.

SERPENTINE (669)

Hydrous magnesium silicate, $3MgO.2SiO_2.2H_2O$. Monoclinic.

Although a common mineral elsewhere, serpentine has seldom been reported from Idaho, possibly having been overlooked because of its inconspicuous appearance and lack of commercial value. The following localities are known:

ADAMS COUNTY

Antigorite, the lamellar or platy variety of serpentine has been listed from the Seven Devils district by Livingston and Laney.[91]

BLAINE COUNTY

Specimens from the Queen of the Hills Mine 1½ miles west of Bellevue (Cat. No. 78,524 U.S.N.M.) consist of a fibrous mineral labeled asbestos, associated with calcite and fragments of sheared black slate. The asbestiform mineral is apparently fibrous serpentine. The calcite is in part in white cleavable granules embedded in the serpentine and is in part fibrous. The serpentine is pale buff in color and forms parallel-fibrous masses the fibers of which bulge around included calcite and are crumpled somewhat at the ends. The fibers reach a length of 11 cm. and individual masses are 5 cm. in breadth. The material has a harsh dry feel and little luster. The fibers are not easily separable and are more or less brittle. No analysis of the mineral has been made, but it is identified as chrysotile by its optical properties. In thin section under the microscope it is pale greenish brown to brown and is pleochroic, the color being more pronounced parallel to the fibers. The extinction is parallel, the elongation positive. The refractive indices vary somewhat but average $\alpha = 1.50$, $\gamma = 1.52$.

CUSTER COUNTY

Serpentine is a meager constituent of the copper-bearing deposits of the Alder Creek district, where it occurs as an alteration product after hornblende and diopside. In a raise from the north Alberta stope to the 300 foot level a band of serpentine with intermixed quartz and malachite follows the fault plane. This layer is about 2 inches wide and shows evidence of much shearing.[92] The serpentine is slickensided and is leek-green in color with a splintery-fibrous structure. It may be classified as the variety known as picrolite.

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[91] D. C. Livingston and F. B. Laney. Idaho Bur. Mines and Geol., Bull. 1, p. 62, 1920.

[92] J. B. Umpleby. U. S. Geol. Survey, Prof. Paper 97, p. 54, 1917.

FREMONT COUNTY

Asbestiform serpentine has been reported to occur north of Ashton.[93]

GARNIERITE (483a)

Variable hydrous silicate of magnesium and nickel approximating the formula $(Ni,Mg)O.SiO_2.H_2O.nH_2O$.	Amorphous.

Garnierite is an indefinite mineral, usually earthy to waxy in appearance with a green color. Where abundant it is mined as a source of nickel as in New Caledonia. Only one report of its occurrence in Idaho has been received.

CUSTER COUNTY

A vein of garnierite of considerable size has been reported to have been found near Clayton in Custer County.[94] Nothing further has been learned about this report. No specimens have been examined.

TALC (484)

Hydrous magnesium silicate, $3MgO.4SiO_2.H_2O$.	Monoclinic.

Talc occurs as a micaceous foliated and very soft mineral with smooth feel and also in less pure form making up beds or masses of rock known as steatite or soapstone. No attention has been paid to its occurrences in Idaho and practically none of importance are known. The clayey materials occurring as gouges along faults and fissures in metal mines in Idaho which the miners call "talc" are not talc but are usually sericite, leverrierite, kaolin or some other clayey mineral.

ADAMS COUNTY

Talc is listed by Livingston and Laney as a mineral of the contact-metamorphic deposits of the Seven Devils.

SHOSHONE COUNTY

A few specimens of talc have been seen in a lot of metamorphic minerals from somewhere in the St. Joe region.

CELADONITE (489)

Silicate of iron, magnesium and potassium, Formula doubtful.	Earthy, soft, minute-scaly.

OWYHEE COUNTY

The rhyolite adjacent to the silver-gold veins of the De Lamar and other mines of the De Lamar district, which has been profoundly altered, contains streaks and veinlets of a greenish-brown fibrous mineral with high double refraction. It is believed to be a magnesian silicate carried up from the underlying basalt. It is, however, neither chlorite nor serpentine for the powder of two rocks in which it was abundantly present yielded no magnesia when treated with sulphuric acid. It is probably a mineral related to celadonite or "green earth." [95]

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[93] Robert N. Bell. 19th Ann. Rept. on Mining Industry of Idaho for 1917, p. 99, 1918.

[94] Robert N. Bell. Personal letter, 1919.

KAOLINITE (492)

Hydrous aluminium silicate, $2H_2O.Al_2O_3.2SiO_2$. Monoclinic.

Ordinary high grade clays such as are used for porcelain, etc., are usually called kaolin, which name includes kaolinite and the corresponding amorphous mineral of the same composition, halloysite.

Considering their widespread occurrence and commercial importance, surprisingly little is known regarding the mineralogy of the clays utilized in the ceramics industries. In addition to kaolinite and halloysite these may include minerals of the sericite-muscovite series and, very recently, it has become increasingly evident that the mineral leverrierite is a clay mineral of widespread occurrence. Kaolinite proper is a completely crystalline micaceous mineral and the best and coarsest examples thus far known are not plastic. The mineralogical nature of clays, if they are homogeneous, may be established by optical examination coupled with determinations of the amount of water contained and the temperatures at which it is released.

Like other similar clayey minerals, kaolinite has its origin in the alteration of feldspars. Formerly it was considered principally a weathering product from the feldspars but a more recent tendency is to attribute a large amount of the kaolinization to hydrothermal processes. The following references to kaolin from Idaho may be quoted from existing literature but no critical discussion of the clays of the State can be offered.

CUSTER COUNTY

Kaolinite occurs in the Alder Creek district along fractures and in cavities in the oxidized ores. It seems to here be a normal product of the weathering of the aluminous garnet and of the igneous rocks.[96]

KOOTENAI COUNTY

Deposits of fine white clay occur near Hutter Station in the Spokane Valley. These clays are very pure but they have not been submitted to a mineralogical examination.

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[95] Waldemar Lindgren. U. S. Geol. Survey, 20th. Ann. Rept., pt. 3, p. 179, 1900.

[96] J. B. Umpleby. U. S. Geol. Survey, Prof. Paper 97, p. 53, 1917.

LATAH COUNTY

Certain deposits of fire clays resulting from the decomposition of granite and pegmatite which are worked at Moscow and Troy have been described by Soper.[97] These are for the most part residual kaolin containing quartz.

OWYHEE COUNTY

Clayey materials are of very frequent occurrence in the Silver City district. Chemical investigation has shown that these vary somewhat in composition, some having the composition of pure kaolin, some of pure sericite, and many corresponding to a mixture of the two minerals. These have already been mentioned under sericite. In addition to kolinite and sericite, leverrierite, discussed below, is present in some mines.

A white clay gouge from the Tip Top vein has a composition intermediate between kaolinite and sericite. A "talc" forming the filling of fissures in the Henrietta mine, which was rich in miargyrite contained:

	Per cent
Water (H_2O) below 100° C	1.70
Water (H_2O) above 100° C	9.40
Potash (K_2O)	1.86
Soda (Na_2O)	Trace.

This may be a mixture of kaolinite and sericite. In the De Lamar mine kaolinite occurs as white chalky or talcose material forming parts of the vein. Sometimes it is a metasomatic replacement of rhyolite. The white "talc" which underlies the "iron dike" in this mine and contains shot and larger masses of argentite (or naumannite q. v.) is apparently pure kaolinite. A specimen from the second level contained: Water 14.12 per cent, potash trace, gold 13.7 ounces per ton, silver 2.30 ounces per ton. Similar material from a veinlet of comb quartz is also probably kaolinite, as it contains no potash.[98]

MONTMORILLONITE AND LEVERRIERITE (492)[98a]

Hydrous aluminium silicate, composition varying from approximately $Al_2O\ .3SiO_2.4H_2O$ to about $Al_2O_3.5SiO_2.7H_2O$.

Monoclinic, clayey.

There are certain clayey materials which have peculiar properties which distinguish them from the ordinary clay minerals kaolinite, sericite, and halloysite. Such a clay was described by Wherry and Larsen from a mine in Colorado and for it the name leverrierite was used while the authors consider rectorite, delanouite, kryptotile, and batchelorite as all being the same material. Since then it has become obvious that this mineral is of very common occurrence and Dr. E. S. Larsen has found, by optical examination, that the clays which have been called bentonite, ardmorite, etc., and which are commonly considered to be altered volcanic dust, are related in their properties but differ somewhat chemically, agreeing with montmorillonite.

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[97] E. K. Soper. Journ. Amer. Ceram. Soc., vol. 1, pp. 94-98, 1918.

[98] Waldemar Lindgren. U. S. Geol. Survey, 20th Ann. Rept., pt. 3, p. 171, 1900.

[98a] It has not been possible to revise the text of this bulletin in accord with recent work on the mineralogy of the clay minerals by Ross and Shannon.

The leverrierite and montmorillonite are completely crystalline, under the microscope, and are biaxial and negative. They have the micaceous platy structure also possessed by kaolinite and sericite. Their optical properties are sufficiently distinctive to permit them to be determined microscopically. Chemically these minerals are characterized by a large water content, a very considerable proportion of which is released below 110° C., as contrasted with sericite and kaolinite, the water of which is not given off much below a red heat. When the mineral powders are dehydrated at 110° C. and allowed to stand in damp air they regain the water which has been lost.

When moist the leverrieritic clays are very plastic. Many of them, especially the varieties of montmorillonite called bentonite, absorb great quantities of water and expand remarkably into a jellylike mass.

One occurrence of leverrierite and one of montmorillonite have been noted in Idaho, the latter a bentonite and the other a gouge clay.

MONTMORILLONITE (bentonite)

BOISE COUNTY

A lot of clay having the appearance and general properties of bentonite was sent to the National Museum for identification by Edward Schwerd, of Boise. A letter directed to Mr. Schwerd asking for details as to the source and occurrence of this material failed to elicit a reply, but it is presumed that the locality is somewhere in the vicinity of Boise.

In the hand specimen this material, dried in the air, appears as a fine-grained compact and homogenous clay of a yellowish to grayish-white color. It is traversed by numerous contraction cracks and has a tendency to conchoidal fracture. It is lusterless until rubbed with a hard object, when it assumes a soap-like polish. The hardness is less than that of gypsum. Fracture surfaces bear small manganese oxide dendrites. When placed in water the material swells very strikingly to a sticky glutinous mass. When stirred with water it settles with moderate rapidity, leaving the water clear. It is almost free from grit. When examined optically the leverrierite of this sample is found to be very fine-grained and micaceous, with moderately high birefringence. It is found to contain a considerable amount of very fine-grained calcite as impurity. The apparent index of refraction is about 1.580, and the material is brown and filled with air inclusions. A sample treated with hydrochloric acid to remove calcite and washed free from acid was analyzed, yielding the following results and ratios. In view of the fact that, owing to its fineness of grain, the material is unsatisfactory for optical study, its homogenous character is not entirely established.

Analysis of bentonite (montmorillonite) from Boise County

(E. V. Shannon, analyst)

	Per cent	Ratios			
Silica (SiO_2)	57.28	0.950	0.956	0.191×5	0.97×5
Titanium dioxide (TiO_2)	.50	.006			
Alumina (Al_2O_3)	16.04	.157	.182	.182×1	.93×1
Ferric iron (Fe_2O_3)	4.02	.025			
Lime (CaO)	1.72	.031	.112	.204×5	1.04×5
Magnesia (MgO)	3.28	.081			
Barium oxide (BaO)	Trace.	------			
Water (H_2O) above 110° C	6.60	.907			
Water (H_2O) below 110° C	10.50				
Total	99.94				

If the bivalent bases be assumed to replace water these ratios give the formula $Al_2O_3.5SiO_2.5H_2O$. In consideration of the fine grain of the clay and the fact that it was not suitable for careful optical work, too much discussion of the analysis is to be avoided.

LEVERRIERITE (gouge clay)[98b]

OWYHEE COUNTY

A clay mineral, which resembles leverrierite, from the Silver City district has been described under sericite. Another and much better characterized leverrierite has been described from the Black Jack mine in the Carson district.[99] This is a specimen (Cat. No. 24, 679, U.S.N.M.) labeled "tallow-clay, Black Jack vein, Carson (Silver City) district." The specimen, which has been cut into a rectangular block, is smooth and resembles a hard soap. Its exterior is pale pink where it has darkened on exposure, but the interior is snowy white. The structure is laminated and platy, and when placed in water the material softens slowly and cracks up gradually. At the end of several hours immersion it had not disintegrated or swelled up in the manner of bentonite. Its hardness in the specimen is about 1, and when it is crushed between the teeth there is an absence of any grit.

Under the microscope the material is transparent, colorless, and entirely crystalline, with a finely foliated or felted-fibrous structure. The elongation of traces of the plates is positive, so that, assuming the acute bisectrix perpendicular to the plates, the mineral is optically negative. The indices of refraction are $\alpha = 1.488$, $\gamma = 1.513$. These indices separate this mineral sharply from sericite and kaolinite, which have higher indices. The material compares, in refractive indices, with the lowest set of values given by Larsen for leverrierite.

[98b] In a forthcoming paper by Edgar T. Wherry this mineral is renamed beidellite.

[99] Earl V. Shannon. Notes on the mineralogy of three gouge clays from precious metal veins. Proc. U. S. Nat. Mus., vol. 62, art. 15, pp. 1–4, 1922.

Heated in the closed tube the clay yields abundant neutral water at a very moderate temperature. In the forceps it decrepitates mildly and fuses with moderate ease on thin edges to a white blebby enamel, the fused portion becoming markedly incandescent. Material which had been proven free from contamination by optical study was available in quantity for analysis, and the analysis was carefully made on ample material. The loss of water at 110° C. was found to be 14.48 per cent, the mineral reaching constant weight at this temperature with 2 hours heating. The first hour the loss was 14.28 per cent. During the second hour additional loss of 0.20 per cent was sustained, while several hours additional heating occasioned no further loss. When exposed again to the air of the room, however, the material proved to be very hygroscopic, and a sample which had been dried to constant weight at 110° C. regained all of its original water content upon standing overnight in the air of the room. A similarly dehydrated sample regained 2.18 per cent of its original weight upon standing overnight in a desiccator over calcium chloride. Samples dehydrated at 110° C. and allowed to stand overnight over sulphuric acid show a gain of several per cent, following which they can not again be brought back to the original dry weight at this temperature. The analysis gave the following results and ratios:

Analysis and ratios of leverrierite, Black Jack vein

	Per cent	Ratios			
Silica (SiO_2)	45.32	0.752	0.752	0.251×3	1.00×3
Alumina (Al_2O_3)	27.84	.272	.276	.276×1	1.10×1
Ferric iron (Fe_2O_3)	.70	.004			
Lime (CaO)	2.76	.049	.056	.280×$\frac{1}{5}$	1.12×$\frac{1}{5}$
Magnesia (MgO)	.16	.004			
Potash (K_2O)	.12	.001			
Soda (Na_2O)	.10	.002			
Water (H_2O) above 110° C	8.16	.453	1.257	.251×5	1.00×5
Water (H_2O) below 110° C	14.48	.804			

These ratios yield the formula: $\frac{1}{5}RO.R_2O_3.3SiO_2.5H_2O$, which may be expanded to $RO.5Al_2O_3.15SiO_2.25H_2O$. Assuming the miscellaneous bases to replace water, the formula obtained is simply $Al_2O_3.3SiO_2.5H_2O$.

Other similar clays occurring in these silver veins as gouges may likewise be leverrierites, but Lindgren's published determinations on many of them made by Hillebrand, as mentioned above under sericite and kaolinite, show too little low temperature water to be leverrierite.

HALLOYSITE (493)

Hydrous aluminium silicate, $Al_2O_3.2SiO_2.2H_2O+nH_2O$. Amorphous

Halloysite is a clay mineral, corresponding to the crystalline kaolinite in composition, which is amorphous and isotropic under the microscope. It is probably a fairly common mineral in Idaho, but few specimens of the clays have been examined microscopically and it has been identified only from one locality, as follows:

BANNOCK COUNTY

A specimen of a clayey mineral sent to the National Museum for identification from Pocatello, Bannock County, is largely composed of an isotropic clay mineral which is doubtless halloysite. The material is stated to occur in large amount near Pocatello. The sample, dry, as received, is slightly creamy white in color and is very light and rather tough. When cut or rubbed it assumes the usual soapy luster. Upon being thrown into water or moistened it very energetically disintegrates into a sandy material which is not plastic. The clay adheres to the tongue and has a strong clayey odor.

Upon being heated for 1 hour at 110° C. the material reached a constant weight with a loss of 12.86 per cent of water. Ignition to a full red heat resulted in the loss of an additional 9.62 per cent. A sample which had been dried at 110° C. gained 3.14 per cent of the original weight in 20 minutes in air and upon standing overnight in air regained all of the water lost at 110°. The mineral, dried at 110° C., and examined microscopically is very cloudy until it soaks up the oil. It is isotropic with and index of 1.550 to 1.552. It contains about 6 per cent of birefracting material, having the appearance of feldspar which shows albite twinning and has a maximum index of refraction of 1.54. This is doubtless albite.

URANOPHANE (503)

Hydrous uranium-calcium silicate, $CaO.2UO_3.2SiO_2.6H_2O$. Orthorhombic.

BOISE COUNTY

The yellow uranium mineral, uranophane, is reported to occur in Boise County at Centerville in the Idaho Basin.[1] The source of this report has not been ascertained and no further confirmation has been received. Inasmuch as monazite, columbite, samarskite, polycrase, and other minerals characteristic of rare earth bearing pegmatites occur in this vicinity, the occurrence of uranophane is to be expected.

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[1] U. S. Geological Survey, Bull. 624, p. 121, 1917.

CHRYSOCOLLA (504)

Hydrous copper silicate, $CuO.SiO_2.2H_2O$. Cryptocrystalline.

Chrysocolla, a mineral requiring further study to determine its exact chemical and mineralogical nature, is an abundant and important copper ore mineral in Idaho. The mineral varies from blue, through various shades of blue-green and green and then to browns, shading into what is described below as copper-pitch ore. It is usually waxy in luster and appearance and massive or botryoidal on free surfaces. Upon microscopic examination the mineral is ordinarily found to be crystalline and birefracting with definite optical properties, but the optical properties vary widely in specimens from different localities. An amorphous and isotropic copper silicate corresponding to chrysocolla has been called cornuite. Chrysocolla frequently resembles malachite, especially when present only as a stain and, of the two green copper minerals chrysocolla is the more abundant in Idaho. The principal occurrences of the silicate in this state are as follows:

ADAMS COUNTY

Chrysocolla is first in order of importance among the oxidized copper ore minerals in the contact-metamorphic copper deposits of the Seven Devils district, and is very abundant in many places, especially in the Arkansas mine. In fact the mineral is forming to-day from drippings in many places in the abandoned workings. It is intimately associated in places with copper pitch ore.[2] The chrysocolla appears in masses of opaline texture associated with malachite and in small veinlets cutting the other vein minerals and penetrating all the interstices. Thin waxy green crusts of chrysocolla result from the alteration of bornite and often encrust masses of bornite (Cat. Nos. 51871, and 67391 U.S.N.M.). Specimens from the Arkansas mine are pure and green of various shades, the structure being massive or small botryoidal. Chrysocolla appears abundantly in ore from Peacock dump and is waxy, translucent, and various shades of pale blue-green, sea-green, sky-blue, etc.

CUSTER COUNTY

Although copper silicates are the most important constituents of the oxidized ores of the mines about Mackay in the Alder Creek district, the silicate ore is characteristically brown in color with vitreous to dull luster and is further discussed under copper-pitch below. Locally the silicate is chrysocolla which is bluish green with a vitreous luster.

Specimens from the Tiger claim contain translucent emerald-green to blue-green or blue chrysocolla with fluorite. Other specimens from this mine consist of garnet rock containing chrysocolla, fluorite, and copper pitch ore. The green chrysocolla grades into a pale bluish-green soft material of faint silky luster. Under the microscope this shows a finely foliated crystalline structure with moderate birefringence. The fibers have parallel extinction with positive elongation. The color in transmitted light is brownish-green in the aggregated fibers with no noticeable pleochroism. The mean refractive index is about 1.615.

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[2] D. C. Livingston and F. B. Laney. Idaho Bur. Mines and Geol., Bull. 1, p. 67, 1929.

Specimens from the Peterson lease contain masses of sky-blue chrysocolla up to 2 cm. in diameter embedded in ferruginous clayey material. The chrysocolla has a radiated structure as though pseudomorphous after malachite.

Specimens from the Copper Bullion tunnel consist of large masses of fairly pure corneous to vitreous blue-green chrysocolla. The chrysocolla has a botryoidal surface where lining small cavities which contain a little copper pitch and malachite.

A bluish-green mass occurring in fluorite from the Empire mine is soft and waxy in appearance and resembles some serpentines. Under the microscope this is finely scaly in structure and entirely crystalline with medium low birefringence. It is biaxial positive with 2V near 0°. The refractive index averages about 1.583 but varies to 1.595. The mineral is easily soluble in cold 1 : 1 hydrochloric acid and the solution contains much copper with no iron, lime, nickel or magnesia. Associated with this is a yellow-green mineral which, under the microscope, appears as radial fibrous spherulites of greenish-yellow color and no notable pleochroism. The extinction is parallel, elongation positive, refractive index above 1.59.

Umpleby noted the crystalline character of the green chrysocolla from the Mackay mines and described it.[3] Under the microscope the material appears as acicular crystals with both parallel and radial disposition and as irregular grains and mammillary crusts. The mineral is uniaxial and optically positive with positive elongation and high birefringence. The indices of refraction, which are slightly variable, are $\omega = 1.46$, $\epsilon = 1.54$. The material is distinctly pleochroic with ω = colorless and ϵ = pale bluish-green. It is hexagonal or tetragonal in crystallization with hardness about 3 and density 2.4. The luster is vitreous, color pale bluish-green, streak white; brittle. An analysis of the purest sample of this chrysocolla which could be selected yielded the following results:

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[3] J. B. Umpleby. Crystallized chrysocolla from Mackay, Idaho. Journ. Wash. Acad. Sci., vol. 4, pp. 181–183, 1914.

Analysis of chrysocolla from Mackay

(R. C. Wells, analyst)

	Per cent
Silica (SiO_2)	39. 3
Copper oxide (CuO)	32. 0
Water (H_2O)	18. 7
Alumina (Al_2O_3), etc	2. 4
Lime (CaO)	1. 7
Zinc oxide (ZnO)	3. 6
Magnesia (MgO)	Trace.
Total	97. 7

The analyzed material of the sample was estimated by microscopic examination, to have the following mineral composition:

	Per cent
Chrysocolla, $CaO.SiO_2.2H_2O$	87. 3
Kaolinite, $2SiO_2.Al_2O_3.2H_2O$	4. 5
Opal, $SiO_2.nH_2O$. (3.85 per cent H_2O)	8. 2
Total	100. 0

The kaolinite occurs as films along microscopic cracks. The associated opal is bluish and contains some copper. The water content of the chrysocolla was found to vary widely. The chrysocolla is often in large masses and grains of the green silicate are often intimately associated with copper pitch ore.

LATAH COUNTY

Some chrysocolla occurs associated with copper pitch and other secondary copper minerals in oxidized copper ores from the Mizpah and other claims of the Hoodoo district.

LEMHI COUNTY

Chrysocolla has been noted as an oxidation product of chalcopyrite in the ores of the Copper King mine on Copper King Mountain in the Eureka district.[4]

ONEIDA COUNTY

Old specimens in the National Museum (Cat. No. 51870, U.S.N.M.) labeled Cariboo mine, Cariboo district, Oneida County, contain waxy blue-green to olive-green masses of chrysocolla up to 5 cm. in diameter. These include grains of chalcopyrite.

SHOSHONE COUNTY

Chrysocolla occurs occasionally in many places in the Coeur d'Alene district in small amounts as a secondary copper mineral. It is less common than malachite in the oxidized lead-silver ores.

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[4] J. B. Umpleby. U. S. Geol. Survey, Bull. 528, p. 76, 1913.

The green silicate is most abundant in the copper area east and south of Mullan. It was the most important mineral of the oxidized ores of the Snowstorm mine, now largely exhausted, where it formed an impregnation in quartzite and coated cracks and open spaces with a translucent greenish blue botryoidal layer. In some cases thicker crusts are made up of concentric and alternating layers of various shades of green or blue-green and greenish-white chalky material or vitreous black copper pitch. A specimen from the third floor above the 800 level, east, consists in the main of green chrysocolla. This is very fine grained, waxy textured and with waxy to dull luster. It varies in color from green, or blue-green to robins egg blue and brown-olive. The green material is overlain by compact white material having the same texture as the chrysocolla and like it, filled with contraction cracks. Under the microscope this white material is nearly transparent and brownish olive-green in color. The smaller pieces are isotropic while some of the larger show pronounced double refraction with sweeping extinction. The latter give a distinct interference figure out of the field indicating them to be biaxial negative with 2V small. The average mean index is 1.612 to 1.618. No pleochroism was noted. In dilute acid this material is not dissolved but copper is extracted. It is probably one of the clay minerals or possibly a serpentine-like substance containing some copper. The chrysocolla of the specimen is like that described below from the Big Elk claim. A specimen from 10 feet beyond the fault on the 800 foot level is rusty quartzite incrusted by a pale-blue transparent minutely botryoidal crust with iridescent luster. Under the microscope this is isotropic with index of refraction ranging from 1.485 to 1.492. It is doubtless copper-colored opal.

A specimen from the Big Elk prospect consists largely of fine waxy blue-green chrysocolla shading through olive-green into greenish-brown and brown limonitic materials. Botryoidal linings of the chrysocolla in cavities have a very thin outer glassy layer. Under the microscope the green chrysocolla is seen mainly as a very fine flaky aggregate, serpentine-like in structure, having appreciable birefringence and a dirty brownish-green color in transmitted light. Its mean refractive index is variable with a mean of about 1.575. The outer layer is made up of transparent aggregates of exceedingly fine fibers in nearly parallel position. It has a high birefringence, parallel extinction and positive elongation. The indices are somewhat variable but α is considerably below 1.50, the exact value not having been measured, while γ is 1.570.

Specimens from the Richmond shaft contain a little green chrysocolla along with much greater amounts of copper pitch.

COPPER PITCH ORE (504a)

MELANOCHALCITE

Impure hydrated copper silicate, variable amounts of iron, manganese, zinc, etc.	Amorphous.

A dark-brown to light-brown or black impure copper silicate containing variable amounts of iron and other substances has long been known by the old German name kupferpecherz or copper pitch ore. This is commonly regarded as an impure variety of chrysocolla, although specimens of doubtful nature and homogeneity have been described from different localities and have been given specific names, such as melanochalcite. The material appears very unlike the fine green opal-like chrysocolla with which it is often associated and, since it is a common ore mineral in Idaho it is here considered separately as a subheading under chrysocolla. The principal Idaho occurrences of this material are as follows.

ADAMS COUNTY

Copper pitch is a common ore mineral in the copper deposits of the Seven Devils district where it occurs intimately associated with chrysocolla, rarely in alternating concentric layers with the green chrysocolla, which it resembles in all respects except color.[5] Much of the copper pitch from this district is dead black in color, opaque and almost lusterless. Much of what has been described from here as melaconite is probably impure silicate. A specimen of the supposed melaconite from the Peacock claim is hard and compact. A small portion, subjected to a very crude analysis gave the following results:

Analysis of "melaconite" from Seven Devils

(E. V. Shannon, analyst)

	Per cent.
Silica (SiO_2)	32. 4
Ferric iron (Fe_2O_3)	12. 8
Copper oxide (CuO)	38. 6
Manganese oxide (MnO)	2. 9
Zinc oxide (ZnO)	3. 4
Water (H_2O) by difference	9. 9
Total	100. 0

This material is doubtless copper-pitch rather than melaconite. A specimen from the Peacock dump shows abundant pitchlike dark brown material forming broad layers surrounding masses of bornite and grading outward into broad bands of green chrysocolla. Specimens from the quartz vein on the Queen claim show considerable masses of similar material in quartz containing residual masses and grains of chalcopyrite. Such copper pitch is also abundant in the Lucky Strike prospect.

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[5] D. C. Livingston and F. B. Laney. Idaho Bur. Mines and Geol., Bull. 1, pp. 37, 67, etc., 1920.

BANNOCK COUNTY

Dead black lusterless copper pitch inclosing much residual bornite in small grains occurs in ore of the Moonlight mine of the Pocatello Gold and Copper Mining Co., in the Fort Hall district.

CUSTER COUNTY

In the Alder Creek district in Custer County copper pitch is abundant in the oxidized ores. Its most common occurrence is in irregular cores which on their borders blend into chrysocolla. The substance seems to grade into chrysocolla in many specimens, but its contact with other minerals is sharp.[6] Specimens of typical ore from the Tiger claim contain masses of vitreous black copper pitch inclosing residual bornite and surrounded by chrysocolla. Specimens from the north tunnel of the Empire mine contain pitch like brown massive material inclosing chalcopyrite. Much of the oxidized ore of the Mackay copper deposits is an impure copper silicate which is characteristically brown in color with vitreous to dull luster and conchoidal fracture. It does not look cupriferous. It is in large part amorphous under the microscope and concentric structures commonly show alternating layers of different shades of red and yellow. An analysis of such brown isotropic ferruginous silicate yielded the results given below:

Analysis of brown silicate ore, Mackay

(R. C. Wells, analyst)

	Per cent
Silica (SiO_2)	29. 6
Copper oxide (CuO)	19. 4
Water (H_2O)	17. 9
Alumina (Al_2O_3) etc	5. 6
Ferric iron (Fe_2O_3)	24. 0
Ferrous iron (FeO)	. 2
Lime (CaO)	1. 9
Magnesia (MgO)	. 5
Total	99. 1

The material of the above analysis contained about 4 per cent of the green crystalline chrysocolla, described above, in isolated crystals, small aggregates, and narrow layers of closely packed fibers.[7]

FREMONT COUNTY

Dark brown copper pitch ore varying from dull through waxy to brilliant vitreous luster, inclosing ragged remnants of chalcopyrite occurs in specimens of ore from the Weimer copper mine, Skull Canyon district.

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[6] J. B. Umpleby. U. S. Geol. Survey, Prof. Paper 97, p. 51, 1917.

[7] J. B. Umplegy. Idem.

IDAHO COUNTY

Brown pitchlike masses of copper pitch occur surrounding chalcopyrite in quartz from the Tom Thumb claim, Lolo Creek mining district. Similar black pitchlike material forms pseudomorphs after masses of chalcopyrite in quartz from the Venture claim, Buffalo Hump district.

LATAH COUNTY

Copper pitch occurs commonly with malachite, azurite, etc., in oxidized copper ore of the Mizpah mine, Hoodoo district, in Latah County.[8]

LEWIS COUNTY

A little copper pitch occurs in copper stained quartz from the Horseman mine, Deer Creek district.[9]

SHOSHONE COUNTY

Copper pitch is one of the commonest secondary copper minerals in the copper prospects of outlying sections of the Coeur d' Alene district. It has been noted from many of the copper mines and prospects in the vicinity of Mullan. It is usually the first product from the breaking down, through oxidation, of chalcopyrite or bornite and the chalcopyrite ores from shallow workings of the prospects is almost invariably invested with an outer halo of pitchlike brown material which penetrates it along cracks.

Specimens from the Snowstorm mine show brown to black material intimately associated with green chrysocolla, sometimes alternating with the green material in concentric layers making up botryoidal crusts. Fine large masses of dark brown material containing scattered remnants of chalcopyrite have been obtained from the Richmond shaft and similar specimens have been seen from almost all of the copper prospects of the Mullan area.

Copper pitch is almost invariably present also in association with chalcopyrite, from which it has been derived, in ores from the numerous copper prospects on the North Fork and Little North Fork of the Coeur d' Alene River.

CHLOROPAL (505)

Hydrous ferric iron silicate, composition approximating $Fe_2O_3.3SiO_2.5H_2O$.	Earthy, amorphous to cryptocrystalline or fine micaceous.

The name chloropal probably covers a number of related silicates differing in composition, optical properties, etc. The most common and best characterized of these is probably the one known as nontronite. The several Idaho occurrences mentioned below have not been studied in detail because of lack of material and the identifications are tentative.

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[8] D. C. Livingston and F. B. Laney. Idaho Bur. Geol. and Mines, Bull. 1, p. 95.

[9] Livingston and Laney. Idem, p. 100.

CUSTER COUNTY

A specimen sent to the National Museum for identification from Challis, by Dr. C. L. Kirtley, consists of a rounded nodule of brown jasper invested in a friable granular green layer which appears to be impure chloropal of the variety known as nontronite.

A specimen from the Reed and Davidson mine, Copper Basin district, is a soft and greenish rock to some extent resembling epidote. This is found, upon microscopic examination, to consist of granular diopside altering to what is probably the nontronite variety of chloropal. The rock contains much magnetite and a little chrysocolla and copper pitch. The chloropal appears under the microscope as confused and felted aggregates of very fine scales of moderately high birefringence which in transmitted light are moderately deep greenish brown in color and show no notable pleochroism. The index of refraction is somewhat variable with a mean of about 1.615 ± 0.005.

SHOSHONE COUNTY

Greenish-brown grains and masses in quartz which contains grains of chalcostibite(?) from the Standard Mammoth mine at Mace are transparent, greenish brown and isotropic to metacolloidal with very fine microcrystalline structure under the microscope. The refractive index is about 1.625 to 1.627. Only a very small amount of the material was available for examination. It was not rare in the mine, however, where it occurred in quartz seams cutting the vein, and plenty of it can be found on the waste dump of the Mammoth lower tunnel. It is probably chloropal, but requires more detailed examination on more material.

HISINGERITE (506)

Hydrated ferric iron silicate, approximately $Fe_2O_3.2SiO_2.4H_2O$. Amorphous.

Hisingerite is a hydrated iron silicate which closely resembles some forms of limonite, on the one hand, or brown opal and much copper pitch ore. It is probably of rather common occurrence, but has been largely overlooked or mistaken for one of the minerals mentioned. The only place where the mineral has been definitely identified is in the Minnie Moore mine in Blaine County.

BLAINE COUNTY

Hisingerite is common in the Minnie Moore mine near Bellevue in the Wood River region, where it was first identified by D. F. Hewett. The material has been subjected to a detailed investigation by Messrs. Hewett and Schaller, whose results will be published.

According to Mr. Hewett's interpretation of the occurrence of the mineral, it has formed by replacement of siderite along cracks by heated solutions which elsewhere deposited zeolites. When first exposed the mineral is blood red in color, but upon drying it assumes the usual pitchy appearance and brown color and becomes filled with contraction cracks.

IDDINGSITE (506a)

Hydrous silicate of ferric iron, etc. (Mg, Ca)O. $Fe_2O_3.3SiO_2.4H_2O$. Orthorhombic

The mineral iddingsite, long recognized microscopically as an alteration product of olivine in igneous rocks, has recently been found to be a well-defined hydrous ferric silicate with definite optical properties. The mineral has been found in the several Idaho localities listed below and probably occurs elsewhere in basaltic or other extrusive rocks.

BOISE COUNTY

Lindgren states that [10] brown-red products from the decomposition of olivine occur in basalt interbedded with the Payette lake beds on the north side of Moore Creek 1 mile above Idaho City.

Iddingsite also occurs in specimens of basalt from Warm Springs Creek in the Bear Valley quadrangle, which contain the zeolites, chabazite, and thomsonite, already described.

OWYHEE COUNTY

Iddingsite occurs in very typical red-brown grains and patches up to 3 mm. in diameter in specimens of basalt from Bernard's Ferry. It is clearly derived by the alteration of olivine. A sample of pure crystalline iddingsite separated from this rock by the use of heavy solutions and an electromagnet was analyzed with the following results:

Analysis of iddingsite from Bernard's Ferry

(E. V. Shannon, analyst)

	Per cent
Silica (SiO_2)	40. 28
Titanium dioxide (TiO_2)	. 12
Alumina (Al_2O_3)	3. 16
Ferric iron (Fe_2O_3)	29. 76
Ferrous iron (FeO)	-----
Lime (CaO)	3. 00
Magnesia (MgO)	10. 36
Water (H_2O) above 110° C	5. 28
Water (H_2O) below 110° C	8. 12
Total	100. 08

The iddingsite is dark reddish brown in thin section and occurs as pseudomorphs after olivine. The larger grains are completely altered to iddingsite, but some of the smaller ones show outer borders of iddingsite around cores of olivine. The iddingsite has very perfect cleavage which, however, is masked by the extreme brittleness of the mineral. Cleavages parallel to the three pinacoids are well developed and there is probably a fourth cleavage parallel to a dome face. The optical orientation is $X=a$, $Y=b$, $Z=c$. The indices of refraction are: $\alpha=1.710\pm0.005$, $\beta=1.722\pm0.005$, $\gamma=1.754\pm0.005$. The optic axial angle varies from 20° to 65°, with an average of about 50°. The optical character is negative, dispersion strong; color red-brown; pleochroism slight.

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[10] Waldemar Lindgren. 18th Ann. Rept., U. S. Geol. Survey, pt. 3, p. 669, 1898.

As has been noted from other localities, there occurs with this iddingsite an amorphous or cryptocrystalline substance derived from the olivine in the same manner as the deeper-colored crystalline material. In some specimens this forms at the core and in others occurs as a border around the crystalline material. A sample of this material, separated from the iddingsite, was analyzed with the following results:

Analysis of cryptocrystalline material associated with iddingsite

(E. V. Shannon, analyst)

	Per cent
Silica (SiO_2)	44. 40
Titanium dioxide (TiO_2)	. 16
Alumina (Al_2O_3)	2. 28
Ferric iron (Fe_2O_3)	29. 00
Lime (CaO)	2. 20
Magnesia (MgO)	7. 12
Water (H_2O) above 110° C	6. 96
Water (H_2O) below 110° C	8. 40
Total	100. 52

This is apparently an amorphous equivalent of the crystalline iddingsite.

TITANITE (510)

Calcium titano-silicate, $CaO.TiO_2.SiO_2$. Monoclinic.

Titanite has been noted at several places in Idaho as crystals in placer concentrates and as small crystals in rocks, but no locality of consequence as a source for mineralogical specimens of the mineral is yet known. The following occurrences have been noted:

ADAMS COUNTY

Titanite is listed by Livingston and Laney[11] as a mineral of the contact deposits of the Seven Devils district.

BOISE COUNTY

Titanite is common as an accessory mineral in rock from the Silver Wreath mine in the Willow Creek district.[12]

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[11] D. C. Livingston and F. B. Laney. Idaho Bur. Geol. and Mines., Bull. 1, p. 62.

[12] Waldemar Lindgren. U. S. Geol. Survey, 18th. Ann. Rept., pt. 3, p. 709. 1898.

CAMAS COUNTY

Titanite occurs prominently in a black sand placer concentrate from Bear Creek, Camas County. The crystals, which are minute vary from pale yellow to greenish in color and show the familiar "envelope" habit bounded by the forms *c*(001), *a*(100) and *n*(111).

CLEARWATER COUNTY

Small yellow crystals similar to the last occur commonly in a placer sand concentrate from Cow Creek in the Pierce district.

VALLEY COUNTY

Titanite is present in numerous crystals in a coarse-grained red granitic rock sent from West Mountain in Valley County by I. W. Phillips, of Pocatello. The crystals reach an extreme diameter of 4 mm. and range from honey yellow or reddish yellow to black. They have the usual envelope habit, but show smaller modifying faces of a number of other and less common forms.

BRANNERITE (519a)

Hydrated metatitanate of Uranium, etc. Orthorhombic or tetragonal.

CUSTER COUNTY

The new mineral brannerite has recently been described as material from a gold placer worked by Henry Sturkey in Stanley Basin in the central part of Idaho.[13] The placer from which the mineral came is near the head of Kelly Gulch in western Custer County. The bedrock in the gulch is said to be granite cut by pegmatite. The brannerite is probably derived from one or more dikes of the pegmatite.

The mineral occurs in the form of grains part of which are prisms and most of which show a prismatic tendency (see pl. 13). They are brownish yellow on the outside but the visible weathering has extended to a depth not exceeding the thickness of paper. Inside they are a brilliant black, with a conchoidal fracture and no sign of cleavage Polished specimens examined under reflected light show the mineral to be remarkably homogeneous. It is, however, traversed by minute cracks which are in part filled with quartz that undoubtedly accounts for the silica shown in the analysis. Although to the eye the mineral is opaque black, under the microscope very thin chips allow sufficient yellowish-green light to pass to make possible optical measurements. The streak is a dark greenish-brown. The hardness is about 4.5, as the mineral will scratch apatite but will not scratch orthoclase. The crystals are not perfect enough to allow a determination of the crystal form but their shapes suggest that they may be orthorhombic or tetragonal. However, E. S. Larsen determined it to be isotropic with an index of refraction for lithium light of 2.26 ± .02 and for sodium light, 2.30 ± .02. It seems probable that it is an isometric paramorph after either a tetragonal or an orthorhombic form as many of the complex pegmatite uranium minerals seem to be. Also like nearly all of the complex pegmatite minerals this mineral is variable in composition and the specific gravity of the specimens tested ranges from 4.50 to 5.43 as determined with the Joly balance. The specimens analyzed had a specific gravity of 5.42 (by pycnometer).

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[13] Frank L. Hess and Roger C. Wells. Journ. Franklin Inst. Philadelphia, vol. 189, pp. 225–237, February, 1920.

The radioactivity of specimens of different specific gravities showed slight differences as tested by the exposure of a photographic plate, those having the highest specific gravity appearing most active (pl. 14). The material was not tested with an electroscope. Pieces of like content of uranium and thorium were selected on the basis of comparative radioactivity. Two of the least active pieces from the seventh row (pl. 14) gave on analysis 35 per cent TiO_2 compared with 39 per cent in the best material.

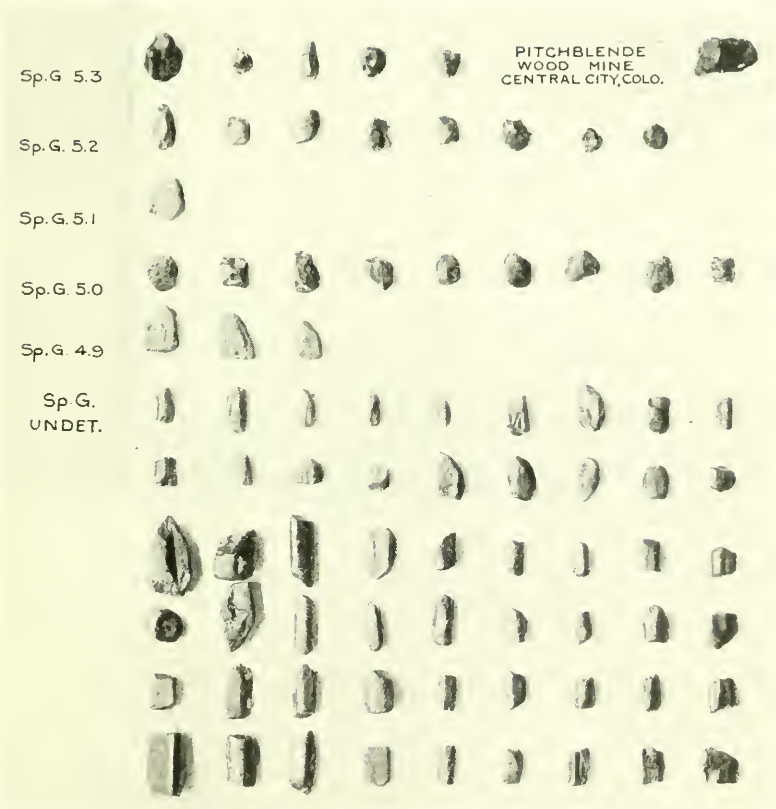
If available in quantity this mineral would be of value as a source of radium, but probably only a few pounds could be secured even at prohibitive cost.

The analysis of such a complex mineral is so difficult that too much weight can not be attached to the percentage figures. The mineral is slowly decomposed by treatment with concentrated sulphuric acid or by hydrofluoric and sulphuric acids. It is more convenient, however, to bring it into solution by gentle fusion with acid sodium sulphate. On dissolving the melt in cold water or dilute sulphuric acid there remains a small residue consisting of silica, unattacked mineral, and sulphates of lead, barium, and strontium. The analysis gave the following results:

Analysis of brannerite from Stanley Basin, Idaho

[R. C. Wells, analyst]

	Per cent	Molecular values
Silica (SiO_2)	0.60	0.010
Titanium dioxide (TiO_2)	39.00	.488
Ferrous oxide (FeO)	2.90	.040
Lime (CaO)	2.90	.052
Uranium dioxide (UO_2)	10.30	.038
Uranium trioxide (UO_3)	33.50	.116
Thoria (ThO_2)	4.10	.015
Ceria (Ce_2O_3)	None.	-----------
Yttria earths (Y_2O_3, etc.)	3.90	.011
Zirconia (ZrO_2)	.20	.001
Lead oxide (PbO)	.20	.001
Barium oxide (BaO)	.30	.002
Strontium oxide (SrO)	.10	.001
Water (H_2O)	2.00	.111
Carbon dioxide (CO_2)	.20	.005
Total	100.20	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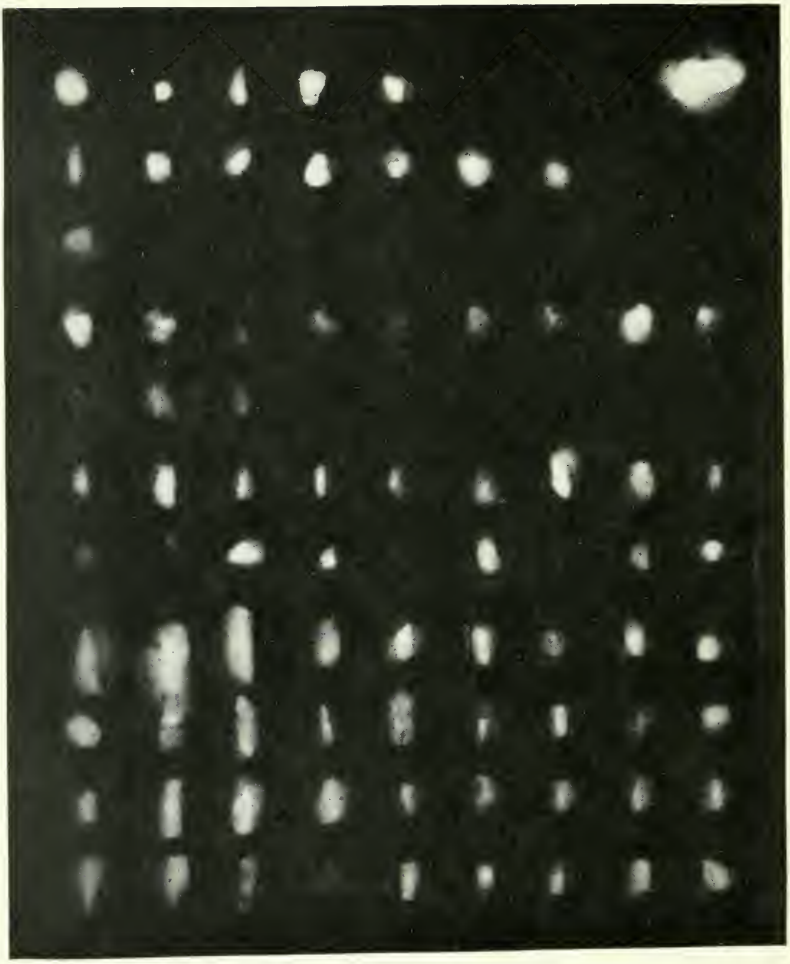
BRANNERITE

FOR DESCRIPTION OF PLATE SEE PAGE 401



Radiograph of Brannerite

For description of plate see page 401

In addition to the above constituents the analysis showed traces of ferric oxide, alumina, and phosphoric oxide. Earlier tests did not definitely identify helium as a constituent of the mineral, but later tests made by more improved methods showed helium to be present in the mineral.[14]

The molecular ratios of the above analysis may be combined as follows:

FeO	0. 040	UO_2	0. 038	CO_2	0. 005
CaO	. 052	ThO_2	. 015	SiO_2	. 010
BaO	. 002	ZrO_2	. 002	TiO_2	. 488
SrO	. 001		. 055		. 503
PbO	. 001				
	. 096				

This leaves $Yt_2O_3-0.011$, $UO_3-0.116$, and $H_2O-0.111$ ungrouped. On this basis the mineral may be simplified to:

RO	0. 096	8. 7
Yt_2O_3	. 011	1. 0
Ro_2	. 055	5. 0
UO_3	. 116	10. 5
TiO_2	. 503	45. 7
H_2O	. 111	10. 1

Without any further combination this yields the approximate formula:

$$9RO.Yt_2O_3.5RO_2.11UO_3.46TiO_2.10H_2O$$

The figures for RO and UO_3 are not very near whole numbers, but this need cause no disappointment, as the whole calculation rests on the assumption that the iron is in the ferrous condition. Although this assumption has certain analogies to support it and is given preference, it would not be entirely unreasonable to assume that part or all of the iron is in the ferric condition. The question can not be settled experimentally in the presence of uranium in two states of oxidation. If all of the iron is assumed to be present as ferric iron the following percentages and molecular values are obtained in place of those first given:

	Per cent	Molecular values
FeO	None.	
Fe_2O_3	3. 20	0. 020
UO_2	18. 40	. 068
UO_3	25. 10	. 089

Appropriate grouping now leads to the approximate formula:

$$2RO.R_2O_3.3RO_2.3UO_3.18TiO_2.4H_2O$$

The bases are apparently present as titanates, metatitanates, or uranotitanates, but an exact evaluation of the relative proportions of these compounds is obviously very difficult and hardly appears practicable in view of the uncertainty concerning the stage of oxidation of the iron and uranium. There is more TiO_2 present than is required to form normal titanates of all the bases, but not enough to form metatitanates without taking some uranium as the basic radicals UO and UO_2. To secure an exact balance any excess of TiO_2 may be reduced to the form of a titanyl metatitanate $TiO.TiO_3$.

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[14] Wells, R. C. Note on brannerite, Journ. Franklin Inst., vol. 189, No. 6, pp. 779–780, June, 1920.

The mineral may be represented as a hydrated metatitanate of various bases, thus: $(Ca,Fe,UO,TiO)TiO_3.(Th,Zr,UO)(TiO_3)_2.Yt_2(TiO_3).H_2O$. Without implying exact molecular ratios the proportions of these four would be about 6 : 8 : 1 : 3, respectively. It is to be remembered, however, that the state of oxidation of the iron is unknown and this ignorance introduces uncertainty in these proportions. Nor is it known whether minerals of this kind should be considered as mixed crystals, solid solutions, or salts of complex acids. The brannerite contains more uranium than any similar mineral except pitchblende. Unlike most others it contains no tantalum or columbium and is very high in titanium.

THE NIOBATES-TANTALATES

The minerals of the several groups included under the heading Niobates-Tantalates have been found in Idaho, with the exception of columbite, only as grains and larger masses in the concentrates from placer gravels, mainly in Boise County, but also in Custer and Clearwater Counties.

The available information regarding these minerals has been, in part, previously presented in an earlier publication by the writer.[15] The minerals mentioned below as tentatively identified in these sands include fergusonite, columbite, polycrase, hjelmite, aeschynite, samarskite, pyrochlore, and euxenite. Of these, columbite is definitely identified and brannerite, a new mineral, has been described in detail above. The identifications of polycrase and samarskite are partially established by crystal form while the other identifications are little better than mere surmises. The mineral listed and described as polycrase is available in amount sufficient for chemical analysis but the other minerals are present only as small grains and their isolation in pure form in amount sufficient for analysis would be a matter of difficulty. The identification of minerals of this class is difficult, since most of them are isotropic, many of them are opaque, and all have very high indices of refraction. Furthermore none have characteristic blowpipe reactions or chemical peculiariarities of diagnostic value. The analysis of any mineral of the group is a task only to be undertaken by a chemist experienced in this particular work and requires much time and a large amount of material.

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[15] Earl V. Shannon. Mineralogy of some black sands from Idaho, etc. Proc. U. S. Nat. Mus., vol. 60, art. 3, pp. 1-33.

The rare-earth minerals are associated in the heavy sands with abundant monazite and their source has not been proven by the finding of any of them in place in matrix, although the fact that they sometimes contain embedded mica and other minerals suggests that they came from the granitic rock. The source is quite probably in pegmatitic phases of the granite and a careful examination of pegmatitic streaks and segregations in the bedrock would doubtless reveal them in place.

FERGUSONITE (523)

Columbate and tantalate of yttrium, erbium, cerium, etc., approximates the formula $(Y, Er, Ce)_2O_3 . (Cb, Ta)_2O_5$. Tetragonal.

BOISE COUNTY

Rare brown resinous grains observed under the microscope in a concentrate from a placer sand from the Idaho City dredge, Idaho City may be fergusonite. In one case a crystal was seen which appeared to have the tetragonal form and pyramidal hemihedrism of fergusonite. When crushed and examined under the microscope the material of these grains is transparent, light brown in color and perceptibly isotropic with very high refractive index.

COLUMBITE (525)

Iron columbate, $FeO.Cb_2O_5$. Orthorhombic.

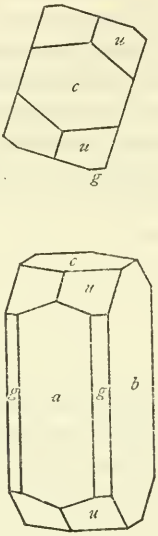
Columbite has been obtained only in Boise County where it occurs as small crystals in heavy sands and also as larger masses probably in pegmatites.

BOISE COUNTY

A separation product from a concentrate from placer gravels worked by the Idaho City dredge at Idaho City, consisting largely of samarskite, contains important amounts of a black mineral in crystals, which proved, upon measurement, to have the angles of columbite. Aside from the difference in form, which is not always manifest, this mineral greatly resembles ilmenite, which occurs commonly in the sands. The columbite makes up about 10 per cent of the samarskite concentrate and is more abundant than samarskite in another concentrate from the same locality which consists largely of garnet.

The columbite crystals vary considerably in habit, ranging from tabular parallel to the pinacoid *b*(010) to square prismatic. The common forms and habits are illustrated in the drawings, Figures 122 to 125, inclusive. The color is black and the luster is more vitreous than metallic. The prismatic planes are usually very brilliant, but the terminal faces are frequently more or less dull or pitted.

This is especially true of the unit pyramid $u(111)$, the faces of which are most frequently dull and often show rounded depressions. Under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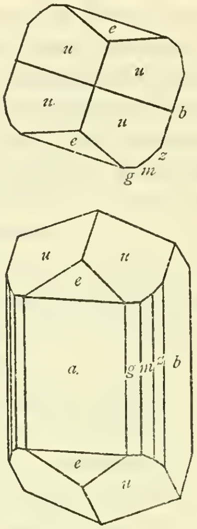
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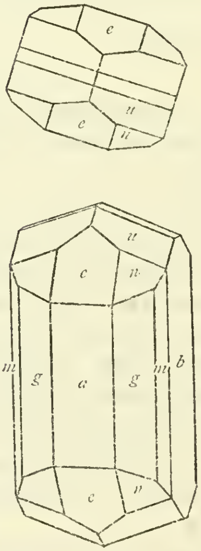
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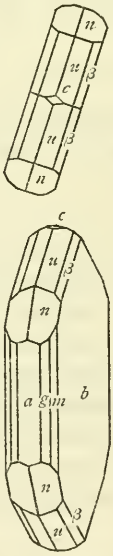
124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125

FIGS. 122–125.—COLUMBITE CRYSTALS FROM BLACK SAND. IDAHO CITY, BOISE COUNTY

the microscope the powdered mineral is translucent on thin edges with a brown color. Frequently several crystals of similar habit are grown together in parallel position and many crystals are attached to small masses of quartz and muscovite. In the coarse, polycrase-bearing sand from Centerville crystals up to 1 cm. in length occur sparingly, which have the form and appearance of columbite. These are invariably dull with a grayish-black color and somewhat metallic luster. These are more opaque than the small crystals described above. Judging from appearance alone it seems probable that these crystals from Centerville are ordinary columbite while the brilliant black crystals from Idaho City are probably higher in their content of tantalic acid and possibly contain some manganese. The forms and angles measured on crystals from Idaho City are given in the following table:

Measurements of columbite crystals from Idaho City

Form		Symbol		Quality, description	Measured				Calculated			
No.	Letter	Gdt.	Miller		φ		ρ		φ		ρ	
					°	′	°	′	°	′	°	′
1	*a*	∞0	100	Very good	90	00	90	00	90	00	90	60
2	*b*	0∞	010	do	0	00	90	00	0	00	90	00
3	*c*	0	001	Poor	-------		0	06	-------		0	00
4	*g*	∞	110	Very good	68	14	90	00	68	05	90	00
5	*m*	∞3	130	do	39	32	90	00	39	38	90	00
6	*z*	∞5	150	Poor	28	20	90	00	26	26	90	00
7	*u*	1	111	Fair	68	23	43	23	68	05	43	48
8	*n*	21	211	Good	78	35	61	16	78	37	61	09
9	*β*	12	121	Poor	52	04	48	36	51	11	48	48
10	*e*	20	201	Good	90	00	60	29	90	00	60	39

In addition to the occurrences of columbite in the heavy sands, the mineral has been found in place in larger masses in this county but the locality is not known. A number of pieces of columbite in the National Museum are labeled as from near Boise. The mineral is typical heavy iron-black columbite, some of the pieces showing crystal faces. The largest fragments in this lot are about 2.5 cm. in diameter and are partly coated with a scaly fine micaceous material.

Another specimen of columbite has recently been received from Boise County. This is a mass of columbite 5 by 7 cm. in size, and Frank L. Hess writes that a much larger mass was received from the same locality by the United States Geological Survey. The specimen consists of an aggregate of crystals, some of which show a few good faces. The columbite shows attached portions of large mica crystals and is obviously from a pegmatite.

SAMARSKITE (529)

Variable complex columbate and tantalate of various bases approximating the formula $3(Fe,Ca,UO_2)O.(Ce,Yt)_2O_3.3(Cb, Ta)_2O_5$. Orthorhombic.

BOISE COUNTY

A sample of a heavy concentrate from a sand from Idaho City labeled "P654, olivine," was found to be strongly radioactive. Careful microscopic examination showed this material to be composed in large part of a coal-black glassy mineral with a brown streak and conchoidal fracture. The mineral occurs in rounded grains and in dull pitted square prismatic crystals which are either broken at the ends or are terminated by a chisel-shaped dome. All of the grains and crystals are very much corroded and are dull and brownish in color on the outside. One of the smoothest of the crystals was measured by light reflected from the faces and gave approximate measurements of 90° between the pinacoids and 86° between the faces of the dome, which compares well with the angle $e(101) : e'(101) = 87°$ for samarskite. The radioactivity of the mineral, its crystal form, and its physical properties suggest that it is samarskite. The identity is by no means definitely established, however, and it is to be understood that this and several other of the rare earth minerals of these sands are but tentatively assigned to the species under which they are described. The hardness of the samarskite is 5–6. The streak is dark brown. When powdered and examined under the microscope the mineral is found to have a dark-brown color and to be transparent only on very thin edges. It is isotropic throughout as are most such rare earth minerals. The form and appearance of the crystals are as shown in Figure 126, which also shows the tendency of two or more crystals to occur in parallel position. The samarskite makes up about 60 per cent of this material, which apparently is the heaviest fraction of a concentrate from a sand obtained from a dredge operating at Idaho City. In addition to the 60 per cent of samarskite, this concentrate contains about 10 per cent of columbite in sharp crystals, the remaining 30 per cent consisting of various other unidentified rare earth minerals, zircon, monazite, garnet, and much metallic lead, the latter evidently being artificial and fragments of solder, shot, or something of the sort whose source is not known. Several other samples labeled "P654, chromite," "P654, garnet," etc., are apparently other fractional concentrates from the same original lot of sand. The one labeled garnet consists of about 50 per cent by volume of brownish-

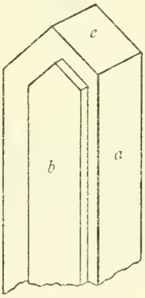

FIG. 126.—SAMARSKITE FROM BLACK SAND, IDAHO CITY, BOISE COUNTY. DRAWN WITH *b*(010) IN FRONT

red almandite in sharp trapezohedral crystals, the remaining 50 per cent being largely samarskite and columbite. The columbite is relatively more abundant than in the first sample examined. The samarskite is entirely like that already described, showing rounded pitted grains and rough crystals. Some of these have grains of quartz and crystals of muscovite attached to them, while others seem to show either two minerals or two generations of samarskite, some of the grains, where broken, showing an inner crystal surrounded by an outer shell of a similar substance. The sample labeled "chromite" contains a little samarskite but is, for the most part, composed of ilmenite.

HIELMITE (531)

Stanno-columbate and tantalate of yttrium, iron, manganese, calcium, etc. Formula doubtful. Orthorhombic.

CLEARWATER COUNTY

Out of a concentrate from a placer mine at Pierce, Clearwater County, labeled "Rutile and aeschynite," there was selected a small waterworn pebble, less than a centimeter in diameter, which was very tough when broken and had conchoidal fracture and very brilliant submetallic to resinous luster. Under the microscope the material of this small mass was doubly refracting with a mean index of refraction between 2.31 and 2.40. The birefringence was 0.02, color very dark brown; pleochroic. Hardness 4.5, specific gravity 6.18; streak red-brown. These properties are nearer those of hielmite than any other of the rare earth minerals. The mass was lost without any chemical tests having been made.

AESCHYNITE (532)

Chiefly a columbate and titanate of the cerium metals. Orthorhombic.

CLEARWATER COUNTY

A lot of waterworn grains and small black pebbles received by the National Museum from Pierce in Clearwater County is labeled "Rutile and aeschynite." Presumably aeschynite has been identified in this material by someone, although most of the pebbles examined by the writer proved to be rutile of unusual colors. One piece was tentatively identified as hielmite and a crystal was measured which could not be identified. Aeschynite may occur, since only a small proportion of the masses, all of which look alike, could be examined.

EUXENITE (534)

Columbate and titanate of yttrium, erbium, cerium, and uranium. Formula doubtful. Orthorhombic.

CUSTER COUNTY

Euxenite has been reported to occur in heavy black rolled pebbles and masses devoid of cleavage or crystal outline in gold-bearing gravels at the head of Kelly Gulch on a claim which is only 300 feet from the low divide between Kelly Gulch and Stanly Basin. The mineral, which is strongly radioactive, has not been quantitatively analyzed.[16] The locality is the same as that which furnished brannerite and the so-called euxenite may have been brannerite.

POLYCRASE (535)

Columbate and titanate of yttrium, erbium, cerium, and uranium. Formula doubtful. Orthorhombic.

BOISE COUNTY

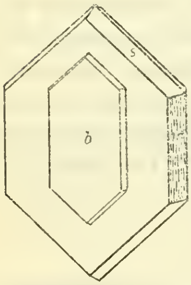

Fig. 127.—Polycrase from black sand. Idaho City, Boise County

A sample of "oversize" coarse sand from a placer concentrate from Centerville contains abundant grains and rough crystals of a dark brownish or greenish-black mineral not very different in appearance from the samarskite. The crystals, which reach 1 cm. in diameter, are orthorhombic in aspect and vary from square-prismatic to thin tabular. They are all coated with a thin exterior crust of a pale-yellow alteration product. Within this shell the crystals and grains consist of a brownish-black glassy material having a conchoidal fracture and a brown streak. Under the microscope the fragments are transparent, isotropic, and brown in color. The mineral is intensely radioactive. Several lots of this material have been received and it seems to be common, especially in the Poncia placer tract. A lot of the fragments of the mineral are shown in natural size in Plate 15, while in Plate 16 is shown a radioactivity photograph made from the same lot of pieces. F. L. Hess has turned a rather large sample of this mineral over to the Museum for investigation which has not yet been undertaken. The properties and appearance of the mineral are identical in most respects with the polycrase of Marietta County, N. C., and for the present it will be referred to that mineral. This mineral, recognizable by its light-colored coating, occurs sparingly also in the samarskite and columbite-bearing concentrates from Idaho City. A crystal from this lot gave measurements on the

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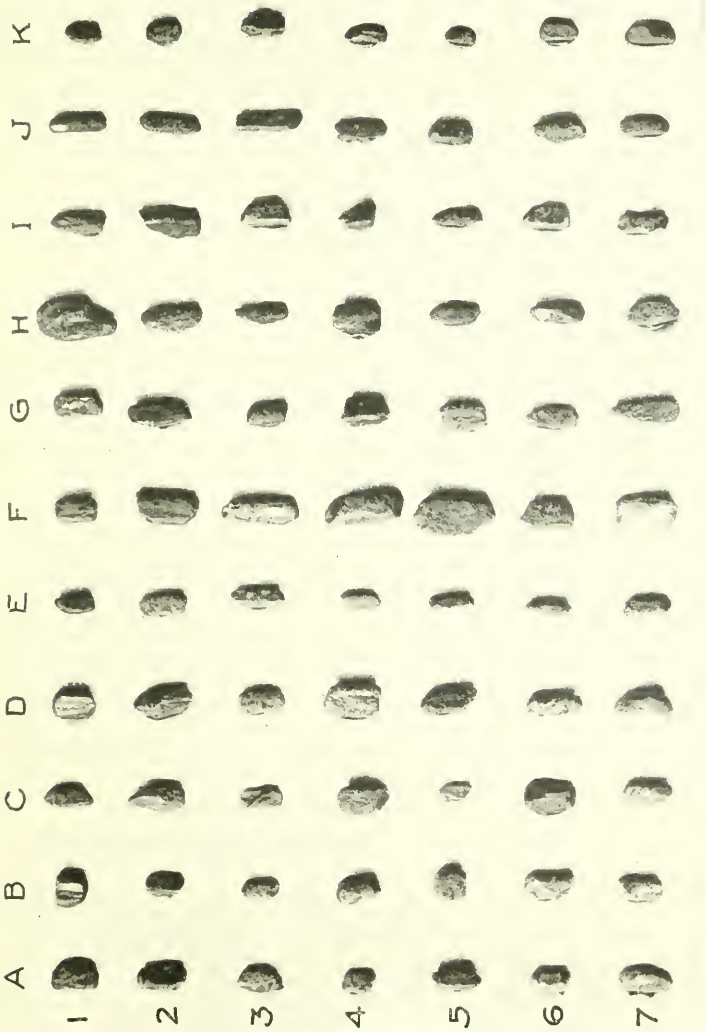
[16] Robert N. Bell. 16th Ann. Rept. Mining Industry of Idaho for 1914, p. 29.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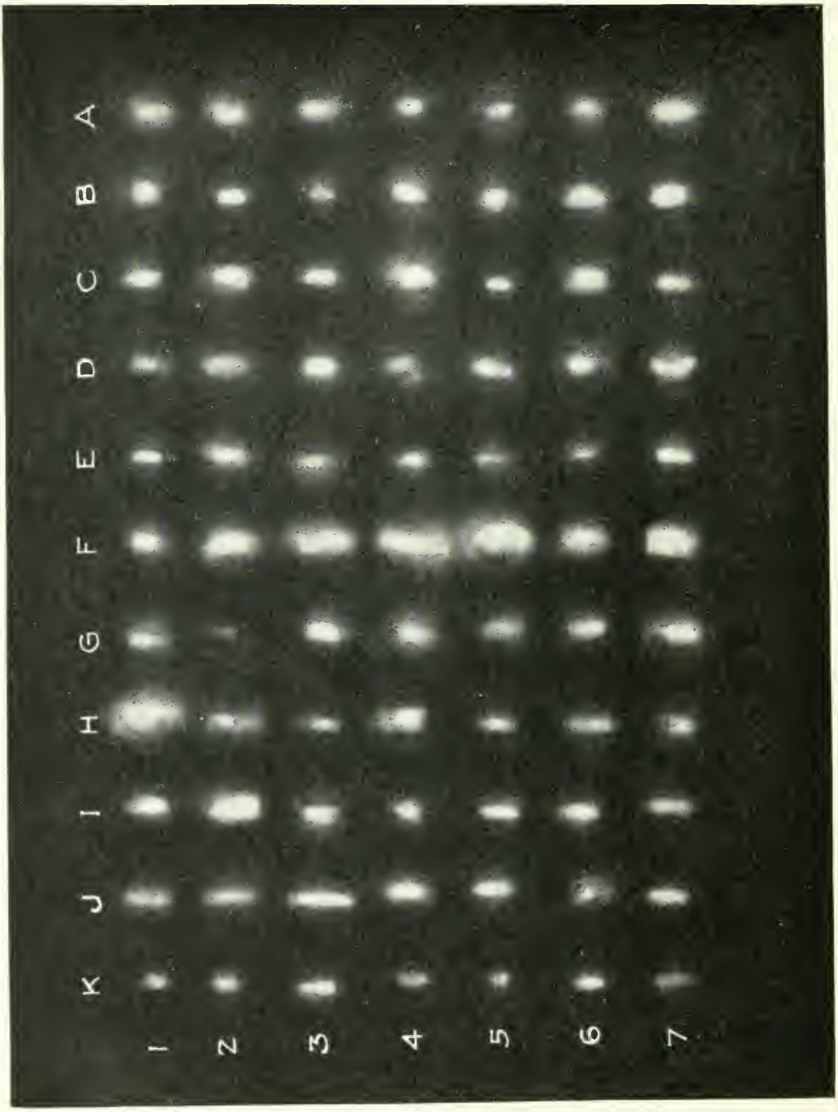
POLYCRASE

FOR DESCRIPTION OF PLATE SEE PAGE 410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RADIOGRAPH OF POLYCRASE

FOR DESCRIPTION OF PLATE SEE PAGE 410

pinacoids and on two pyramid faces indicating roughly the form *s*(111) of polycrase. The remaining faces were coated. The form and appearance of this crystal, which is tabular, are shown in the drawing (fig. 127). There is, as shown in the figure, a smaller crystal in parallel position projecting from the face of the larger individual.

The so-called Poncia tract, from which the most of this mineral has come, is worked by Carlos Poncia in Swede Gulch near the center of section 9, township 7 north, range 5 east, 1½ miles southwest of Pioneerville. The polycrase is concentrated in the heavy sands with brilliant crystals of yellow monazite and colorless zircon.

MONAZITE (537)

Phosphate of the cerium metals	Monoclinic.

$(Ce, La, Di)_2O_3.P_2O_5$.

Monazite is abundant in a number of places in Idaho as a constituent of concentrates from the gold-placer deposits. The presence of this mineral in the State was first recognized by Lindgren [17] in the gold placers of the Boise Basin, where he found it as a resinous brown mineral in subangular grains in part exhibiting crystal faces. Roughly quantitative analyses by Hillebrand made upon the purified sand showed the principal constituents to be phosphoric acid and cerium earths, with a small amount of thorium. The absence of yttrium earths showed that xenotime probably was absent. Later, Day,[18] in his work on the black sands of the Pacific slope, reported the mineral from 37 localities in 10 counties in Idaho. Some of these are in error, since several of the sands listed are from Snake River localities, and a reexamination of the same samples failed to detect any monazite. Schrader has recently [19] described the occurrence of monazite in Nez Perce County.

BOISE COUNTY

The monazite occurs most abundantly in the gold-placer region about Centerville, in Boise County, and preparations were made some years ago by the Centerville Mining & Milling Co. to recover and clean the sand for market. The plant which was built was burned before any important production was made and the commercial outlook was not sufficiently bright to encourage its rebuilding. At present the only value which attaches to monazite is dependent on its thorium content. The Idaho monazite is seemingly lower in its thorium content than similar sands from Brazil and North Carolina, which are more cheaply mined, and the Idaho localities can not successfully compete in the limited market. The potential commercial value of the Idaho deposits is dependent upon the development of uses, which will create a market demand for the cerium metals which are the essential constituents of monazite. With the rapid advances of chemical and metallurgical industry this event will probably occur at no very distant date.

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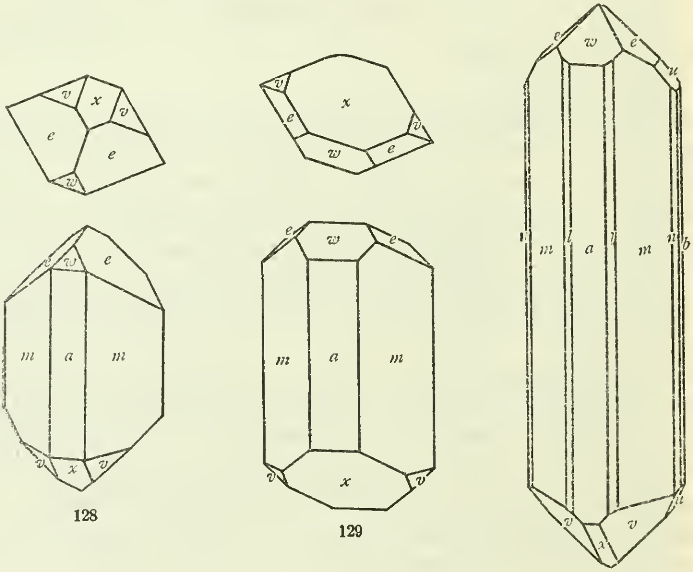
[17] Waldemar Lindgren. U. S. Geol. Survey, 18th Ann. Rept., pt. 3, pp. 677–679, 1898.

[18] David T. Day and R. H. Richards. U. S. Geol. Survey, Mineral Resources of United States for 1905 pp. 1195–1201, 1906.

[19] Frank C. Schrader. An occurrence of monazite in northern Idaho, U. S. Geol. Survey, Bull. 430, pp., 184–190, 1910.

The work of the several geologists who have examined the Idaho monazite-bearing area seems to indicate that the monazite is an original mineral present as an accessory constituent of the granitic rock of the great central Idaho batholith. Lindgren panned crystals of both monazite and zircon from angular granite soil formed by the disintegration of the granite on slopes where these minerals could have no other source. The nature of the mineral, monazite, its occurrence elsewhere throughout the world, and the fact that it is not invariably present in drainage basins in the granitic area probably indicate that it occurs, not in the normal granite, but in the small coarsened pegmatitic streaks and veins which are locally abundant in the granitic mass.



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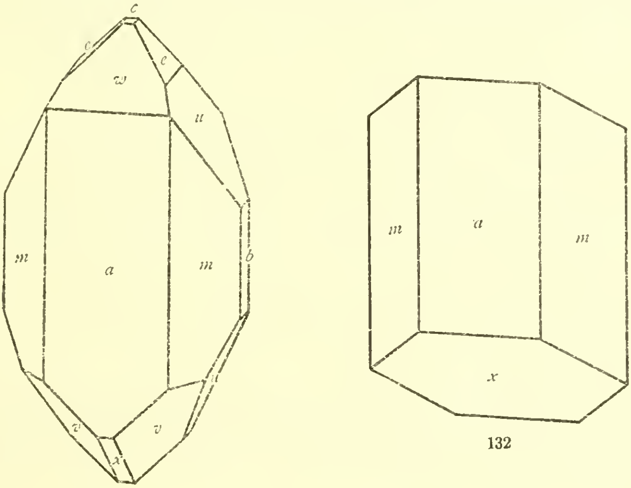
129

130

Figs. 128–130.—Monazite crystals from placer concentrates. Boise County

The description of the monazite from the localities in Boise County will suffice for that from all of the other places where this mineral has been found in the State since they present no essential differences. In color it is commonly resinous golden-yellow to amber or orange brown. Only a few crystals were found which had what could accurately be described as a greenish tinge, the associated green grains being usually augite, titanite, or olivine. A few green and a few perfectly colorless transparent monazite crystals were seen in the columbite-samarskite concentrate from Idaho City described above. The monazite is, for the most part, in sharp and perfect crystals, although many of the larger crystals are broken or abraded. The average diameter of the monazite in the screened sands is less than 1 mm. but in one "oversize" sample from Centerville rough crystals up to 5 mm. in diameter were observed, and larger masses may have been discarded by screening. In form the monazite from all of the localities represented is very similar. The five figures were all drawn from measurements made upon crystals selected from a sand from Centerville and subsequent examination of numerous other sands did not reveal any additional forms, combinations, or habits. The smaller crystals are often flawless and transparent, while the larger individuals are more or less opaque from the presence of numerous cracks and rifts. The forms noted on the crystals are few in number and perhaps 90 per cent of those seen had the habit shown in figure 128 and 10 per cent the form shown in Figure 129. Figures 130, 131, and 132 represent quite unusual habits. The simple habit shown in Figure 132 is characteristic of some of the very largest crystals as well as of the colorless and green monazites seen in the samarskite concentrate. The more prominent faces on the crystals gave fairly good reflections and the agreement between the angles measured and the theoretical angles is rather good. The averages of the measurements are given in the following table.



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Figs. 131–132.—Monazite crystals. Boise County

Angles measured on monazite from Centerville

Form		Symbol		Quality, description	Measured				Calculated			
No.	Letter	Gdt.	Miller		φ		ρ		φ		ρ	
					°	′	°	′	°	′	°	′
1	*a*	∞0	100	Very good	90	00	90	00	90	00	90	00
2	*b*	0∞	010	do	0	00	90	00	0	00	90	00
3	*c*	0	001	Very poor	89	58	13	23	90	00	13	40
4	*m*	∞	110	Very good	46	44	90	00	46	43	90	00
5	*n*	∞2	120	Good	27	35	90	00	27	58	90	00
6	*l*	2∞	210	Very poor	69	15	90	00	64	47	90	00
7	*e*	01	011	Good	14	25	43	37	14	43	43	44
8	*w*	10	101	Very good	90	04	50	43	90	00	50	48
9	*v*	−1	$\bar{1}11$	Good	$\bar{3}8$	43	49	43	$\bar{3}8$	37	49	50
10	*u*	02	021	Very good	7	36	61	38	7	29	61	49
11	*x*	−10	$\bar{1}01$	do	90	09	36	31	90	00	36	29

In the Idaho Basin, where the occurrence is typical, the monazite is a heavy yellow sand associated with the gold in placer washings. It is associated with much ilmenite and considerable zircon and lesser amounts of rare earth minerals. It is more abundant in some places than in others, but is universal in its distribution. A sample from the sandy lake beds forming the false bedrock in a gravel bench at the junction of Moore and Granite Creeks, 3 miles east of Idaho City, gave 0.025 per cent of heavy residue containing sharp crystals of ilmenite, no magnetite, sharp zircons, and abundant greenish to yellowish grains of monazite which rarely show crystal faces. After extraction of the ilmenite the remaining sand was 70 per cent monazite and contained 48 per cent of oxides of the cerium metals and 1.20 per cent of thoria.[20]

Inclusions in the monazite are not abundant and it is rarely attached to any other mineral. In one case a hexagonal tablet of biotite was seen embedded in a crystal and another crystal was penetrated by a tabular crystal of ilmenite.

CLEARWATER COUNTY

Monazite was found in a number of concentrates from the Pierce district in the usual yellow crystals entirely like those from Boise County. It is associated with titanite, from which it is difficult to distinguish, in a sand consisting largely of ilmenite and rose pink garnet.

NEZ PERCE COUNTY

The occurrence of monazite in Nez Perce County has been carefully described by Schrader[21] who writes that the mineral is common along the Musselshell Creek and probably occurs also in the adjoining valleys. It is associated with the placer gold and is more concentrated in the lower part and on the bedrock than in the upper part of the gravel. It seems to be more plentiful in the ancient gravels than in the recent. Several partial analyses of nonmagnetic portions of concentrates from Musselshell Creek gave the following results:

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[20] Waldemar Lindgren. U. S. Geol. Survey, 18th Ann. Rept., pt. 3, p. 677, 1898.

[21] Frank C. Schrader. An occurrence of monazite in northern Idaho, U. S. Geol. Survey, Bull. 430, pp. 184-190, 1910.

Partial analyses oj monazite concentrates

[R. C. Wells, analyst]

	(1)	(2)	(3)	(4)
Phosphoric acid (P_2O_5)	10.90	8.90	15.50	8.70
Thoria (ThO_2)	1.20	1.15	1.85	.88

Computation from the content of phosphoric acid shows that the analyzed samples range from 32 to 55 per cent of monazite. When cleaned to about 90 per cent monazite, the usual commercial grade, these sands average about 3 per cent ThO_2. On a basis of pure monazite the thoria content would be about 3.3 per cent.

OTHER LOCALITIES

Monazite has been reported as occurring in similar manner in placer sands in a large number of localities in Idaho. Specimens from these localities have not been available for examination by the present writer. The mineral is to be expected in most of the gold districts in the central Idaho granitic area.

APATITE (549)

Calcium chloro- and fluo-phosphate, $9CaO.3P_2O_5.Ca(F,Cl)_2$. Hexagonal, hemihedral.

The calcium phosphate apatite has been noted only from Lemhi County, although it probably is not so rare in the State as this might indicate.

LEMHI COUNTY

A specimen from the Togo claim, Blackbird district, contains dull, yellowish rough tabular crystals of apatite up to 1 cm. in diameter associated with green rosettes of chlorite in cavities in schist. Optically the apatite is biaxial and negative with 2V very small. The refractive indices are $\alpha=1.630$, $\beta=1.640$, $\gamma=1.643$. The mineral is easily soluble in 1:1 nitric acid and the solution reacts for phosphoric acid.

Another specimen from the Haynes Stellite mine, in the Blackbird district, contains long slender white prisms of apatite embedded in quartz and associated with cobaltite. As shown in the photograph of this specimen reproduced in Plate 6, lower, the apatite prisms are broken into sections and the fractures are filled with dark-colored mica or chlorite.

COLLOPHANITE (549a)

PHOSPHORITE, PHOSPHATE ROCK

Calcium phosphate, $9CaO.3P_2O_5.CaO.CO_2.H_2O+nH_2O$. Amorphous.

Collophanite is the mineral which makes up the phosphoric acid-bearing portion of the phosphorite or rock phosphate which occurs in all of the southeastern counties of Idaho and adjoining counties of Wyoming and Utah in very great amount. This area probably constitutes the largest reserve of high-grade rock phosphate in the world, and much of the land is now in Federal phosphate reserve. While not of especial interest from the mineralogical viewpoint, these deposits are of great practical importance as such phosphate rocks are used in the manufacture of soluble phosphates which are essential to plant growth and which must be used in the fertilization of agricultural lands. The phosphorite deposits have been thoroughly investigated by the United States Geological Survey and for detailed descriptions of the field the reader is referred to the several publications on the subject by G. R. Mansfield and others.[22] The following description is copied from one of these reports.

The phosphorite is characterized by an oolitic texture which may be lacking where the grain of the rock has been destroyed by pressure or shearing. The ovules are rounded grains built up in roughly concentric structure and range in size from extremely minute specks to bodies a centimeter or more in diameter. Many of them are irregularly flattened as though worn by attrition. The ovules are in general darker than the matrix and many of them have a shiny black coating like desert varnish.

When fresh the rock is dark brown to almost black in color, but that which has weathered is light bluish-gray. The rock which has lost its oolitic texture through metamorphism or pressure does not turn light upon weathering. The phosphate rock and associated limestone emit a strong bituminous-fetid odor when struck.

The rock-phosphate deposits are original sedimentary formations laid down at the time that part of the earth's surface was largely covered with water. Since the time in which the phosphatic strata were deposited other sediments have been accumulated, so that many thousands of feet of subsequent strata have overlain or succeeded them. The deposits are more properly analogous to coal and limestone and to the Clinton iron ores of the Appalachian region than they are to ore deposits such as veins or lodes or to alluvial deposits of the placer type.

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[22] F. B. Weeks and W. F. Ferrier. Phosphate deposits in western United States. U. S. Geol. Survey, Bull. 340, pp. 441–447, 1908.

R. W. Richards and G. R. Mansfield. Preliminary report on a portion of the Idaho phosphate reserve. U. S. Geol. Survey, Bull. 470, pp. 371–440, 1911.

Hoyt S. Gale and R. W. Richards. Phosphate deposits in Idaho, Wyoming, and Utah. U. S. Geol. Survey, Bull. 430, pp. 457–535, 1910.

R. W. Richards and G. R. Mansfield. Geology of the phosphate deposits northeast of Georgetown, Idaho. U. S. Geol. Survey, Bull. 577, 1914.

A. R. Schultz and R. W. Richards. A geological reconnaissance in southeastern Idaho. U. S. Geol. Survey, Bull. 530, pp. 267–284, 1913.

Thin sections of the richest oolitic ore show under the microscope that the rock consists mainly of ovules or concretions of a cryptocrystalline substance which, in some concretions, is surrounded by banded zones of crystalline fibers with local isotropic bands, all having the same average index of refraction (about 1.60) and apparently representing the phosphatic substance. In some places the interstices are filled with calcite and in others with an isotropic material which appears to be identical with the cores of the concretions. The fibrous material has parallel extinction. The isotropic substance is probably collophanite and the doubly refracting substance may be called quercylite which. however, is not a definite mineral, but a mixture of different members of the series of lime phosphate minerals.[23]

In some specimens the black phosphate rock is cut by thin seams of gypsum and rather frequently it is coated along cracks with purple fluorite.

Two specimens have been examined carefully by the writer during the course of this work and these were probably typical of the coarse and fine types of the material. The first of these was collected by G. R. Mansfield and the locality is given as on the west side of the Teton Basin in southeastern Idaho. This is conglomeratic in texture and consists of vitreous black ellipsoidal pebbles or concretions up to 5 mm. in diameter in a somewhat friable brownish matrix. In thin section this rock is seen to be made up of rounded masses of a material which is brown in transmitted light and in part opaque from inclusions. Surrounding these masses is calcite which penetrates them along fractures and replaces them to a slight extent. The concretionary masses are either isotropic or show that feeble aggregate birefringence characteristic of metacolloidal substances. Occasional angular grains of clear quartz are included in the concretions and small angular cavities within them have been lined with a finely fibrous layer of chalcedonic structure, the fibers of which have parallel extinction and positive elongation. The index of both the isotropic and cryptocrystalline material is 1.613 ± 0.003. The isotropic material is doubtless collophanite while the birefringent material may be called quercylite. The collophanite gave a distinct fluorine reaction with potassium bisulphate.

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[23] Waldemar T. Schaller, quoted by R. W. Richards and G. R. Mansfield. U. S. Geol. Survey, Bull. 470, pp. 376–378.

The second sample of "typical hard ore" from the Waterloo phosphate mine at Montpelier is a coal black dense rock with a finely oolitic structure. In dilute hydrochloric acid it effervesces giving off carbon dioxide, having a fetid bituminous odor, from the matrix which dissolves first leaving the partly round and partly subangular vitreous black phosphate granules in relief. Heated to a red heat the matrix burns white while the granules remain black accentuating the structure. Under the microscope the phosphate is isotropic and varies from light brown to opaque black. The index of refraction averages about 1.630.

An interesting fact recently pointed out by G. R. Mansfield of the United States Geological Survey is that the better grade phosphate rock carries vanadium in amount varying from 0.11 to 0.52 per cent V_2O_5.[24] The phosphate deposits, all of which are about alike occur in Bannock, Bear Lake, Bingham, Bonneville, and Madison counties.

PYROMORPHITE (550)

Lead chlor-phosphate, $9PbO.3P_2O_5.PbCl_2$. Hexagonal.

Pyromorphite is a secondary lead mineral which is not common in the western United States. It occurs sparingly in several mining districts in Idaho and abundantly in places in a large number of localities in the Coeur d'Alene district where very fine specimens have been obtained.

BOISE COUNTY

A specimen from Hall Brothers' property, Deadwood Basin, Deadwood district, contains tufts of minute acicular crystals of pale yellow-green color and larger irregularly formed deep blue-green prisms of pyromorphite. The pyromorphite is associated in the specimen with cerusite.

IDAHO COUNTY

Specimens labeled "Vanadate of lead" from the Mallard Creek prospect of W. Sendke, in the Dixie district, bear small green grains and imperfect crystals of pyromorphite on quartz which contains galena and light yellow sphalerite.

Another specimen, likewise labeled "Vanadate of lead" from the Comstock mine, Dixie district, consists of cavernous rusty quartz containing aggregates of minute yellow-green crystals. Examined under the microscope these are seen to be hexagonal prisms with pyramidal terminations which are pleochroic in yellow-green parallel to the elongation to colorless perpendicular to the elongation. These contain no vanadium but react strongly for phosphoric acid and hence are doubtless pyromorphite.

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[24] G. R. Mansfield. U. S. Geol. Survey, Mineral Resources of United States 1922, pt. 2, p. 116, 1923.

LEMHI COUNTY

Pyromorphite occurs as minute yellow-green to green crystals coating quartz in specimens from the Isis claim, Mineral Hill district, 7 miles north of Shoup.

SHOSHONE COUNTY

Pyromorphite has been found in fine specimens in a number of mines in the Coeur d'Alene district. Many of the specimens from this district were equal to those supplied by any other locality in the world and the only other locality in the United States comparable to the Coeur d'Alene in the beauty and excellence of its specimens is the Phoenixville region in Pennsylvania.

In this county the pyromorphite is usually characteristic of the upper portion of the oxidized zone. In color it is most commonly some shade of pale yellow-green or green, although colorless, pink, gray, or brown varieties are occasionally found. The mineral generally forms drusy crusts of small crystals coating rusty rock fragments. These often show only the unit prism and basal pinacoid (fig. 136), although narrow beveling faces of the unit pyramid are frequently present (fig. 133) and, very rarely, narrow faces of the second order prism. The prism faces are usually deeply furrowed horizontally and are frequently curved or bulging giving the crystal a barrel shape. In many specimens the tips differ sharply in color or transparency from the balance of the crystal and the basal pinacoid, while sometimes smooth and brilliant, is often replaced by a cup-shaped depression. Some crystals fray out at one or both ends into bundles of fibers and rarely the mineral is wholly fibrous. Parallel growths are common and frequently large aggregates in parallel position taper to a small point by which they are attached. Imperfectly crystalline masses occurred in the Senator Stewart mine and wholly massive pryromorphite of vitreous appearance and conchoidal fracture occurred in the Blackbear mine. Smooth small botryoidal coatings of pyromorphite occurred in the Quaker tunnel. Frequently the crystals are imperfect and occur as branching forms of a green color which coat dark iron or manganese stained rock fragments and bear some resemblance to mosses, green lichens, or other plant growths.

As a rule the pyromorphite occupies cracks in low-grade gangue or in wall rocks of small fissures somewhat removed from the richer ore bodies, the lead of the pyromorphite having apparently migrated somewhat in solution. Because pyromorphite-bearing portions of the mines were seldom rich enough to work the mineral has not been entirely removed and may still be found in the old surface workings of some mines. Good specimens are still available in several places, notably the Little Giant, Blackbear, and other mines.

This is the only lead mineral which has been found in the district which contains either chlorine or phosphoric acid and the source of these radicles is not known. The pyromorphite is habitually a solitary mineral and is seldom immediately associated with other lead minerals. One specimen from the Hercules mine contains green crystals of pyromorphite scattered through crystalline white cerusite like phenocrysts in a porphyry. A specimen of white cerusite from the Stewart mine is coated on one side with a thin crust of green pyromorphite. White pyromorphite is associated with the plattnerite from the You Like mine and pinkish pyromorphite occurred with galena in the Caledonia mine.

The following localities for this mineral have been noted in the district:

The Hercules mine, above Burke, furnished numerous specimens of pyromorphite in well-defined green prismatic crystals, some of them of fairly large size. Some single crystals have been obtained which are 3 cm. long by 1 cm. in diameter, a few of which are hollow tubes.

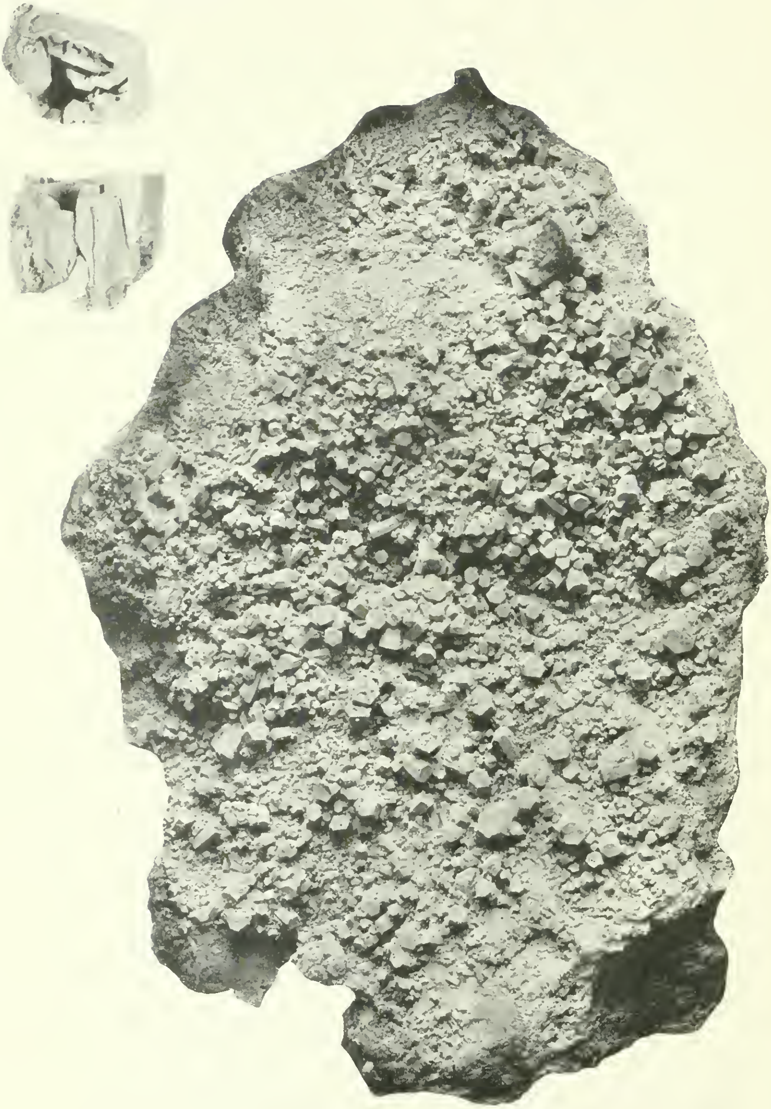
Fine pyromorphite is reported to be common or abundant in the Ambergris mine, on the Ninemile Creek side of the ridge near the Hercules mine. None of this has been seen by the writer. Good specimens are also reported from the Tamarack and Custer mine.

This mineral is common in the upper workings of the Standard and Mammoth mines at Mace. Specimens showing deep green prismatic crystals have been collected from the dump of one of the uppermost tunnels of the Standard and from the dump of the No. 2 tunnel of the Mammoth. A large amount of this mineral was obtained in a seam along a fault cut by a drift from the No. 2 tunnel of the Mammoth mine and specimens may be obtained here as long as the tunnel remains open.

To judge from reports and from the material remaining in the dumps pyromorphite was the principal secondary lead mineral in the upper portion of the Blackbear ore body at Blackbear. There are specimens consisting of thin drusy coatings and massive green pieces of the mineral available on the dumps of this mine.

George Huston reports that at one time a mine car full of pyromorphite was taken from a lead bearing vein in the Snowstorm copper mine at Mullan.

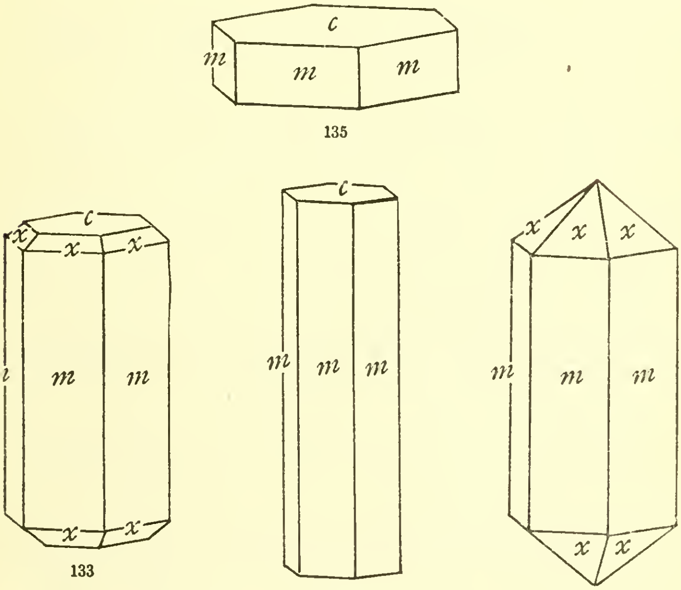
One of the principal localities for the lead phosphate in the district is the Little Giant mine near Mullan. This prospect is reached by a dim trail which ascends the mountain south from the Mullan cemetery. This trail is shown on the topographic map (United States Geological Survey Coeur d'Alene special topographic sheet) and terminates at the tunnel which extends into the ridge in an easterly direction at an elevation of about 4,750 feet on the east side of a small stream known as Silver Creek, which turns sharply west and descends



PYROMORPHITE

For description of plate see pages 421 and 423

into Boulder Creek. This locality was visited in 1916 when the mouth of the tunnel was partly closed by caving soil but the interior was safely open. The tunnel is a drift on a vein consisting mainly of coarsely crystalline white barite and pyromorphite is abundant nearly throughout its length as small green to grayish or brown crystals incrusting manganese-stained barite. It should furnish numerous specimens to anyone venturing the rather arduous climb, although it may be necessary to dig a passageway through the entrance. Specimens from here are illustrated in Plates 17 and 19.



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133

136

134

FIGS. 133–136.—PYROMORPHITE CRYSTALS FROM SHOSHONE COUNTY

Pyromorphite occurred associated with the plattnerite of the You Like lode, now part of the Morning mine, as described under plattnerite. It formed both grains and hexagonal prismatic crystals up to 1 cm. long which were white or gray except where stained brown or black by coatings or inclusions of plattnerite. None of this pyromorphite had the usual green color.

In the Evolution prospect, below Osburn, pyromorphite has been noted in the tunnel at the valley level where there is a considerable excavation in oxidized material where the tunnel first encounters the oxidized portion of the large calcite vein. The pyromorphite forms tabular colorless crystals (fig. 135) in ocherous limonite or stout pale green minute prisms coating the hanging wall.

Pyromorphite has not been definitely noted in the several surface workings of the Bunker Hill mine nor in the Last Chance or Tyler mines.

In the Omaha prospect, which encountered and merged with the Caledonia mine workings, long prismatic colorless pyromorphite crystals (fig. 136) were found coating cracks in iron and manganese-stained quartzite. In another place near the point where the Sandow tunnel crosses the Caledonia line a pocket containing cup-shaped olive green crystals was encountered in the roof of the tunnel.

In the Caledonia mine large and beautifully crystalline pale-green masses of pyromorphite were found in the Howard stope above the 300-foot level in considerable amount. Lower in the mine, as deep as the 900-foot level, a peculiar pinkish pyromorphite occurs coating cracks in galena or in quartzite adjacent to bodies of galena ore. This pyromorphite has been previously described as follows [25]: The mineral occurs commonly in crusts of minute crystals coating cracks in galena or as larger crystals in cracks in quartzite. The color ranges from faintly pink to colorless in the smallest crystals to quite deep grayish violet in some of the largest ones. In size they range from microscopic to an occasional length of 1.5 cm., the larger being those in the wall rocks. Those over 5 mm. in length are commonly nearly opaque with curved prism faces and brush-like terminations. The luster in the smaller crystals is adamantine, while that of the larger opaque crystals is resinous. Quite commonly the crystals are attached by a prism face and are then doubly terminated, the habit being essentially like figure 134, with the length several times the diameter. At times the small prisms greatly resemble quartz crystals, the resemblance being heightened by an unequal development of the pyramid faces which gives them a trigonal aspect. While promising in appearance the crystals are somewhat dull and give poor reflections. The forms noted were the pyramid $x(10\bar{1}1)$ and the prism $m(10\bar{1}0)$. The best crystal measured gave the value ρ for the pyramid $= 40° 25'$, which is sufficiently close to the calculated value, $40° 22'$ to identify the form. It is of interest to record that Rush J. White, a mining engineer of Wallace, whose observations are reliable, has noted the occurrence of pyromorphite in well-formed crystals on the mine timbers of an abandoned drift on the 200-foot level of the Caledonia mine.[26]

An unusual amount of pyromorphite was encountered in the Senator Stewart mine in the No. 3 tunnel, which is just below the grade of the railroad to the Arizona tunnel of the Last Chance mine in Deadwood Gulch. When the No. 3 tunnel was being driven to intersect the ore body a small vein was encountered not far from the portal in which the lead was all in the form of pyromorphite in greenish-yellow masses and small drusy crystals. A short raise was driven on this vein and from a small stope which was opened some 30 tons of pyromorphite were shipped as ore. Some pyromorphite was encountered elsewhere in seams in the walls of this tunnel.

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[25] Earl V. Shannon. Crystals of pyromorphite. Amer. Journ. Sci., vol. 43, pp. 325-327, 1917.

[26] Quoted by J. B. Umpleby. Geology and ore deposits of Shoshone County, Idaho. U. S. Geol. Survey, Bull. 732, p. 63, 1923.

Pyromorphite was also found abundantly as crusts and druses in the Quaker tunnel, opened for litigation purposes by the Bunker Hill Co., above the Arizona railroad grade and west of the upper workings of the Senator Stewart mine on the same slope.

This mineral has been found on the outcrop of the Northern Light mine on Pine Creek as pale-green crystals in cavities in quartz seams in slate.

The Lookout Mountain mine, on the high mountain east of the forks of Pine Creek, has recently produced some very fine specimens of pyromorphite. A large green crystal from this locality is illustrated in Plate 17. Specimens from the outcrop of the vein contained numerous colorless crystals of pyromorphite and other specimens from the vein show prismatic crystals, some of which have narrow faces of the second order prism, on quartz.

The Sierra Nevada mine in Deadwood Gulch has encountered pyromorphite in places in the flat oxidized vein which is now exhausted. During the operation of this mine under the Peeples lease in 1914, good specimens of small yellow-green stout prisms and larger barrel-shaped bulging deep olive-green crystals coating quartzite were obtained in the Clark winze.

Pyromorphite has been reported from the Hypotheek mine in French Gulch south of Kingston, although no specimens from this mine have been seen by the writer.

This mineral probably occurs elsewhere in the district and a moderate number of good specimens can probably still be obtained in a number of places.

MIMETITE (551)

Chlor-arsenate of lead,
$9PbO.3As_2O_5.PbCl_2$. Hexagonal.

Mimetite the arsenic analogue of the more common pyromorphite appears from available records to be a rare mineral in Idaho. Only two localities have been mentioned.

BLAINE COUNTY

Mimetite or "arsenicite of lead" is reported to occur in the Wood River district.[27]

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[27] Mint Report 1881, p. 179, quoted by Waldemar Lindgren. U. S. Geol. Survey, 20th Ann. Rept., pt. 3, p. 213, 1900.

CUSTER COUNTY

A mineral identified as mimetite occurs as minute yellow prismatic crystals in a cavity in galena-tetrahedrite ore from the Ramshorn mine, Bayhorse district (Cat. No. 56520, U.S.N.M.). Under the microscope these are seen to be hexagonal prisms terminated by a hexagonal pyramid which gave as an average for its ρ angle 40° 25′ against the calculated value for $(10\bar{1}1)$ for mimetite which is 40° 02′. The mimetite crystals rest upon white cerusite crystals and are largely replaced by the lead-copper arsenate bayldonite (q. v.).

VANADINITE (552)

Chlor-vanadate of lead, $9PbO.V_2O_5.3PbCl_2$. Hexagonal.

Only a single locality for vanadinite has been authentically reported from Idaho, in the Spring Mountain district in Lemhi County. Vanadate is reported from the Dixie district in Idaho County, but specimens of the supposed vanadinite proved upon examination to be pyromorphite.

LEMHI COUNTY

Vanadinite has been identified by Mr. H. T. Stearns in a specimen collected in the tunnel of the Iron Mask mine, owned by William Clark of Leadore, on Spring Mountain in the Spring Mountain district.[28] The mineral forms yellow-brown tabular crystals up to 2 mm. broad by ½ mm. thick on manganiferous limonite. A crystal measured by the present writer from Mr. Stearns' specimen was bounded by the base $c(0001)$ and the prism $a(10\bar{1}0)$ with very narrow beveling line faces of the prism $b(11\bar{2}0)$ and the pyramid $x(10\bar{1}1)$. The ρ angle for the pyramid measured is 39° 28′, which compares well with the calculated value for vanadinite, which is 39° 26′. Vanadium was found qualitatively in the mineral by Mr. Stearns and Frank L. Hess.

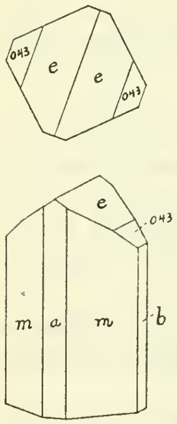

Fig. 137.—Olivenite crystal, showing new form (043). Blackbird district. Lemhi County.

OLIVENITE (561)

Hydrous copper arsenate, $4CuO.As_2O_5.H_2O$. Orthorhombic.

LEMHI COUNTY

Olivenite has been identified in a specimen from the Nickel Plate mine on the Little Deer Creek side of the divide, 2 miles northeast of the Uncle Sam mine in the Blackbird district. It forms druses of dark olive-green crystals of small size in cavities in a cellular quartz matrix containing residual granular patches of cobaltite. The olivenite is associated with a bright yellow-green alteration product of earthy texture which consists in the main of scorodite but which contains some olivenite.

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[28] Harold T. Stearns. Note on the first discovery of vanadinite in Idaho. American Mineralogist, vol. 8, pp. 127-128, 1923.

Under the microscope the olivenite is transparent and pale blue-green in color. Optically it is biaxial positive with 2E large, dispersion perceptible $r<v$. Sections perpendicular to an optic axis show no extinction in white light. The α index of refraction is below 1.79 while β and γ are above 1.79. It is easily soluble in cold dilute hydrochloric acid and gives qualitative reactions for copper and arsenic. It contains no iron.

The crystals are somewhat dull externally and are not well suited for goniometric measurement. They have the habit shown in figure 137. The angles measured are as follows:

Measurements of olivenite from Lemhi County

Form		Symbol		Quality, description	Measured				Calculated			
No.	Letter	Gdt.	Miller		φ		ρ		φ		ρ	
					°	'	°	'	°	'	°	'
1	a	$\infty 0$	100	Good	90	26	90	00	90	00	90	00
2	b	0∞	010	do	0	00	90	00	0	00	90	00
3	m	∞	110	do	46	49	90	00	46	31	90	00
4	e	01	011	Fair	0	02	33	20	0	00	34	15
5	l*	$0\frac{4}{3}$	043	Good	0	02	42	17	0	00	42	13

The form l(043) is new for olivenite but, in view of the close agreement between the measured and calculated angles it can be regarded as well established.

TRICHALCITE (596)

Hydrous copper arsenate, $3CuO.As_2O_5.5H_2O$. Orthorhombic.

The rare arsenate, trichalcite, has been identified optically in a specimen from the Liberal King vein in Shoshone County as described in a previous paper.[29]

SHOSHONE COUNTY

The specimen containing the trichalcite is from the dump of the upper tunnel of the Liberal King claim which adjoins the property of the Lookout Mountain Mining Co. on the high mountain east of the forks of Pine Creek.

On the dump of this tunnel there is a heap of porous quartz, containing original pyrite, arsenopyrite, and chalcopyrite, which is brilliantly colored by secondary blue, green, and yellow oxidation products in thin films. The most abundant of these minerals, the blue-green one, has a vitreous to pearly luster and resembles tyrolite.

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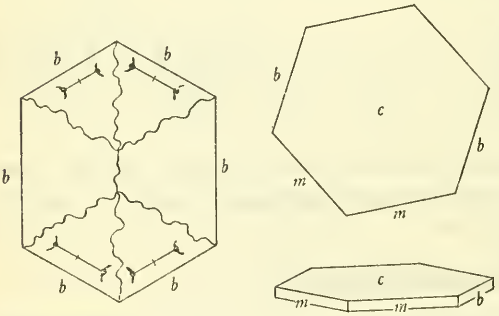
[29] Earl V. Shannon. Mineralogic notes on pyrite, pucherite, trichalcite, and wavellite. Proc. U. S. Nat. Mus., vol. 62, art. 9, 1922.

It gave qualitative reactions for copper and arsenic and was found by A. Rodolfo Martinez to have optical properties in agreement with those given in Larsen's tables for trichalcite as shown by the following comparison:

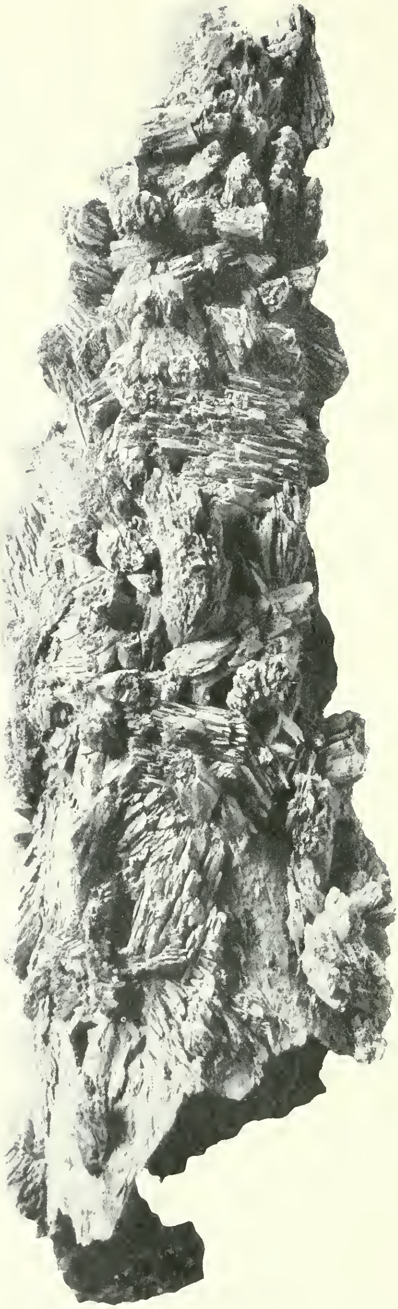
Comparison of optical properties of trichalcite

Pine Creek, Idaho (Martinez).	Turginsk, Urals (Larsen).
Color pale bluish-green.	Color pale bluish-green.
Nonpleochroic.	Nonpleochroic.
Biaxial.	Biaxial.
Sign negative (−).	Sign negative (−).
2V large.	2V large.
α=------.	α=1. 67±0.01.
β=1. 688.	β=1. 686±0. 003.
γ=------.	γ=1. 698±0. 003.
Birefringence medium low.	Birefringence 0.028.
X normal to plates.	X normal to plates.



Figs. 138–139.—Trichalcite. Liberal King Claim, Pine Creek, Shoshone County

Upon examination of the specimen under a binocular microscope it was found that the mineral was in thin tabular crystals of hexagonal aspect and although these were very minute it was found possible to measure two of them on the 2-circle goniometer. The basal pinacoid gave good signals but the very narrow prismatic planes were more or less curved and irregular, yielding only approximate measurements accurate, perhaps, to 1°. These indicated 60° angles for the prismatic zone, the mineral thus simulating hexagonal crystallographic symmetry. Examination of the measured crystals in polarized light shows them to be made up of biaxial orthorhombic sectors as shown in Figure 138. The sectors have interlocking boundaries and each sector has well-defined cleavage parallel to its edge. The end sectors give parallel extinction and in convergent light give a perfectly centered biaxial interference figure. The lateral sectors have a confused structure as though made up of overlapping plates. It is evident that the several apparently prismatic planes of the pseudohexagonal tablet are pinacoids of several orthorhombic units which go to make up the twinned group. It is probable that trichalcite is orthorhombic, with a prism angle near 60°, and that it has a tendency to form pseudohexagonal twins like aragonite, cerusite, chalcocite, etc. Figure 139 is drawn to show in orthographic and



VIVIANITE INCRUSTING FOSSIL TUSK

FOR DESCRIPTION OF PLATE SEE PAGE 427

clinographic projections, a hypothetical untwinned crystal of the mineral.

VIVIANITE (597)

Hydrous iron phosphate, $3FeO.P_2O_5.8H_2O$. Monoclinic.

Vivianite has been noted in specimens from three localities in as many counties in Idaho, described as follows:

CLEARWATER COUNTY

A paper has previously been published calling attention to several vivianite specimens which are from Clearwater County[30] and are now in the National Museum (Cat. No. 87220, U.S.N.M.). These which are broken parts of what was originally one mass were received as a gift from Charles Brown and John Pearson of Dent, Idaho, through W. B. Compton, who writes that the material was found in a gold placer mine 17 feet below the surface. The extreme fragility of the specimen proves conclusively that the mineral was formed in the situation where found. The largest specimen, which is illustrated in Plate 18, has the form of a hollow curved, tapering cone, which is somewhat triangular in cross-section and is composed entirely of crusted crystals of vivianite. The general shape of the object was so suggestive of that of a horn or tusk that it was submitted for examination to James W. Gidley and Charles W. Gilmore of the Division of Vertebrate Paleontology in the United States National Museum, who both agree that the deposit represents the mold of a horn or tusk, but owing to the total removal of all of the original material and the absence of definite structure in the crystalline vivianite remaining, definite opinions could not be given as to the exact character of the animal to which it belonged. Mr. Gidley thinks that the original object was probably the horn of a long-horned bison or the tusk of a walrus, the point being too acutely tapering to be the tip of a mammoth tusk. Mr. Gilmore, however, has pointed out a tendency of tusks of the mammoth to develope a cone-in-cone structure and to separate, upon weathering, into a succession of horn-shaped segments having much the form of the interior cavity of the vivianite specimen. On chemical grounds it is apparent that the tip portion of a horn of this length, owing to its low content of mineral matter, would scarce supply the amount of phosphoric acid represented by the vivianite.

The exterior of the specimen, as shown in the photograph, is made up of masses of vivianite crystals. The crystals are grown outward from a thin platy layer which, while also consisting of vivianite, apparently outlines the original object and has a remotely fibrous appearance as though deposited between thin plates of bony material which had exfoliated somewhat under the influence of weathering. Inside the cone there is a second layer of vivianite crystals which have grown inward from the platy layer. The latter are somewhat smaller than those of the exterior layer. The central cavity of the specimen is in part filled with sandy material, grains of which are embedded in the crystals of the interior crust. This sandy material has the appearance of residual granite sand.

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[30] Earl V. Shannon. Description of vivianite incrusting a fossil tusk from gold placers of Clearwater County, Idaho. Proc. U. S. Nat. Mus., vol. 59, pp. 415–417, 1921.

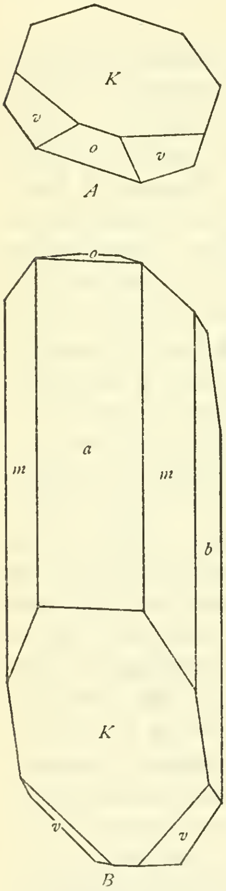

Fig. 140.—Vivianite. Prismatic crystal from fossil tusk, Clearwater County

The crystals of the exterior crust are well formed and are aggregated into groups, the individuals of which deviate a few degrees from strict parallelism. These are developed in a manner showing that they grew freely without interference, and there are no grains of sand or other substance attached to the faces nor do the faces contain the impressions of any such grains. Some of the recesses between the crystals are partly filled with waxy limonite which is filled with contraction cracks and which is readily brushed away from the vivianite crystals leaving them clear and bright.

Individual crystals of the vivianite reach a maximum length of 2 cm. with a diameter of 1 cm., while aggregates of crystals in nearly parallel position reach a length of 4 cm. with a thickness of 2 cm.

The crystals are all alike in development, being prismatic by elongation of the prism $m(110)$, the orthopinacoid $a(100)$ and the clinopinacoid $b(010)$. The terminations are chisel shaped and consist of $o(\bar{1}03)$, $v(\bar{1}11)$, and $K(\bar{3}01)$, the dominant orthodome $K(\bar{3}01)$ being a form not previously recorded on vivianite. The habit of the crystals is shown in Figure 140. The faces of $m(110)$ are in all cases clear and brilliant, yielding excellent reflections of the signal, while the orthopinacoid $a(100)$ is irregular and $b(010)$ is usually dull. The terminal planes are all more or less etched and dulled, sometimes to such an extent that no light is reflected at all. The new dome $K(\bar{3}01)$, while present as a broad face, yields blurred signals which do not permit accurate measurements. The average rho angle from several measurements was 67° 45′, while the calculated rho for this form is 68° 37′.

In color the vivianite is light greenish blue, although this is obscured by the presence between and around the crystals of a pulverulent deep blue alteration product. The cleavage parallel to *b*(010) is very prominent, yielding flexible laminae. Under the microscope the pleochroism of some grains is very striking and beautiful.

IDAHO COUNTY

A specimen from the Gold Hill property in the Dixie district contains vivianite in the form of broad blue plates coating fractures in an altered dike rock.

OWYHEE COUNTY

Vivianite has been observed in colorless to deep blue crystals in clay in the Trade Dollar, Black Jack, and other silver mines of the Silver City district in Owyhee County. A crystal from this district which is now in the Field-Columbian Museum has been described by Farrington and Tillotson.[31] The crystal measures 35 by 17 by 11 mm. in size and is completely developed with the habit shown in Figure 141. It is transparent and dark green by transmitted and azure blue by reflected light. The forms present are *a*(100), *b*(010, *m*(110), *w*(101), and *v*(111). The angles measured with a contact goniometer on this crystal are below compared with the calculated angles:

	Measured	Calculated
	° ′	° ′
a(100) : *m*(110)	36 30	35 59
a′(100) : *w*(101)	56 00	54 40
b(010) : *v*(111)	58 00	60 13

ERYTHRITE (601)

COBALT BLOOM

Hydrous cobalt arsenate, $3CoO.As_2O_8.8H_2O$. Monoclinic.

Erythrite is a prominent mineral in the cobalt mines of the Blackbird district and it has recently been identified from a locality in Shoshone County.

LEMHI COUNTY

Cobalt bloom occurs as an earthy incrustation of pink and pearl-gray color on the outcrops of cobalt deposits of the Blackbird district. In places, as on the Beliel group, this mineral is so abundant on the faces of cliffs that it can be seen for half a mile or more.[32] A specimen collected by Mr. Frank L. Hess of the United States Geological Survey from the Haynes Stellite Co.'s mine consists of black tourmaline-quartz rock containing fibrous coatings of beautiful rose-red erythrite along seams and cracks.

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[31] O. C. Farrington and H. W. Tillotson, jr. Field Columbian Museum Publications, Geological Series vol. 3, p. 163, 1908.

[32] J. B. Umpleby. U. S. Geol. Survey, Bull. 528, p. 77, 1913.

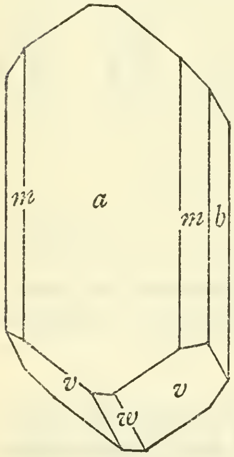
A specimen from the Bulkley mine contains thin blades and rosettes of rose-red erythrite in rusty schist.

In ore from the Hawkeye claim erythrite forms a pink pulverulent efflorescence and deep rose-red spherulites on cobaltite in quartz.

Fine pink blades and rosettes occur in quartzite from the Brooklyn claim. A crystal from here which was measured is illustrated in two positions in Figures 142 and 143. This is tabular to the *b*(010) face and shows a termination formed of both the negative pyramid *v*(111) and the positive pyramid *x*(111), the latter a new form. The angles measured are as follows:

Measurements of erythrite, Brooklyn claim

Form		Symbol		Quality, description	Measured		Calculated	
No.	Letter	Gdt.	Miller		π	ρ	π	ρ
					° ′	° ′	° ′	° ′
1	*b*	0∞	010	Poor	0 00	90 00	0 00	90 00
2	*m*	∞	110	do	55 07	90 00	54 05	90 00
3	*x**	+1	111	Fair	60 55	54 10	60 10	54 40
4	*v*	−1	111	do	46 21	44 18	44 56	44 40



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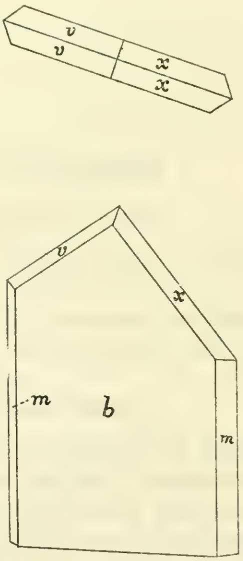

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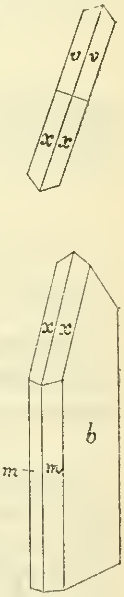

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FIGS. 141–143.—141, VIVIANITE. SILVER CITY DISTRICT, OWYHEE COUNTY. AFTER FARRINGTON AND TILLOTSON. 142–143, ERYTHRITE. BROOKLYN CLAIM, BLACKBIRD DISTRICT, LEMHI COUNTY. SAME CRYSTAL DRAWN IN TWO POSITIONS

SHOSHONE COUNTY

Erythrite has recently been identified optically and by qualitative chemical tests in cavities in an ore containing a cobaltiferous gersdorffite in specimens sent to the National Museum by Erwin Ploetzke from a prospect 1 mile from the mouth of Slate Creek near Avery in the St. Joe Basin in Shoshone County. The erythrite occurs as crusts and druses of rose pink crystals which are too small for measurement. Under the microscope these are lath-shaped and are optically biaxial with 2V large. The extinction $Z \wedge c$ is $-33°$. The mineral is pleochroic with Y = colorless, Z = brownish pink. The acute bisectrix is perpendicular to the flat cleavage fragments. The mean refractive index β is 1.660, ±0.002.

ANNABERGITE (602)

NICKEL BLOOM

Hydrous nickel arsenate, $3NiO.As_2O_5.\ 8H_2O$. Monoclinic.

The only reported locality for the nickel arsenate is in the Blackbird district in Lemhi County.

LEMHI COUNTY

Annabergite is reported to occur with erythrite as a conspicuous constituent of the outcrops of the cobalt deposits of the Blackbird district.[33] It is probable that the identification is not definite, but is based by analogy with the occurrence of erythrite. Such green arsenates as have been examined from this district contain no nickel and, considering the very small amount of nickel in the primary ores, annabergite must be very rare, if it occurs at all. A specimen labeled "Nickel bloom," from the Alpha claim, stated to occur abundantly as float on the surface of the divide and to be typical of material occurring commonly at most of the prospects in the camp, consists of ferric iron arsenate with some copper, probably principally in the form of scorodite. It contains no trace of cobalt or nickel. Another green alteration product surrounding residual patches of cobalt in ore from the Nickel Plate claim consists of a mixture of olivenite and scorodite and contains no nickel.

SCORODITE (607)

Ferric iron arsenate, $Fe_2O_3.As_2O_5.4H_2O$. Orthorhombic.

Scorodite is probably a mineral of common occurrence in Idaho in thin yellowish to green films and stains which have resulted from the oxidation of arsenopyrite. In a few places in the State it has been found in larger and better characterized masses. The optical properties of the mineral are so variable and the mineral so frequently occurs as cryptocrystalline or very fine-grained aggregates that it is almost impossible to determine or identify the mineral optically. The principal localities from which the mineral has been obtained are as follows:

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[33] J. B. Umpleby. U. S. Geol. Survey, Bull. 528. p. 75, 1913.

BLAINE COUNTY

Scorodite occurs in the ore of the Golden Bell mine in the intrusive granodiorite at the head of Minnie Gulch in the Hailey district. It forms an incrustation in the oxidized portion of the vein.[34]

CASSIA COUNTY

Scorodite occurs in some abundance associated with cinnabar in prospects near Black Pine in Cassia County.[35] The scorodite is blackish olive green in color with a small botryoidal surface. It shows no evidence of crystal form, and the interiors of the botryoidal masses are compact with a subconchoidal fracture and no trace of cleavage. The mineral is translucent and the luster is somewhat greasy. The fracture is difficult, the material being very tenacious. The specific gravity as determined on a fragment by the Kraus modified Joly balance is 3.016. An analysis of the scorodite yielded the following results:

Analysis of scorodite from the Black Pine district

(E. V. Shannon, analyst)

	Per cent
Insoluble	0. 32
Arsenic pentoxide (As_2O_5)	44. 40
Phosphoric acid (P_2O_5)	4. 80
Ferric iron (Fe_2O_3)	34. 02
Lime (CaO)	Trace.
Magnesia (MgO)	Trace.
Alumina (Al_2O_3)	Trace.
Chromium oxide (Cr_2O_3)	. 32
Water (H_2O) above 110° C	12. 25
Water (H_2O) below 110° C	5. 08
Total	101. 19

LEMHI COUNTY

Scorodite is apparently common or abundant in the Blackbird district, in Lemhi County, where it has passed under the name "nickel bloom," apparently being mistaken for annabergite. Yellow green earthy material surrounding residual nuclei of cobaltite in quartz of a specimen from the Nickel Plate mine is probably scorodite. It reacts qualitatively for arsenic and ferric iron. Under the microscope the material is faintly birefracting to amorphous isotropic with an index of refraction of about 1.74. The scorodite of this specimen is associated with olivenite.

A specimen from the Alpha claim, top of the hill, Blackbird district. This specimen, which was labeled "Nickel bloom," is said to be typical of a great deal of float on the top of the divide scattered over 8 or 10 claims and very common at most prospects in the camp. This is an earthy appearing pale yellow-green material. Under the microscope it is greenish brown in color and transparent and is completely crystalline with moderately high birefringence and a finely aggregate structure. The index of refraction varies slightly between 1.76 and 1.78. Some of the smaller grains are minute prisms with inclined extinction, $Z:c=20°$, and these have $\alpha=$ approximately 1.76 and $\lambda=$ much higher, possibly 1.79. The mineral dissolves readily in dilute hydrochloric acid. It contains abundant ferric iron and arsenic and considerable copper and no ferrous iron, nickel, or cobalt.

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[34] D. F. Hewett. Oral communication.

[35] E. S. Larsen. Univ. of Idaho School of Mines, Bull. 2, pp. 65–67, 1920.

BAYLDONITE (629)

Hydrous copper-lead arsenate, $3CuO.PbO.As_2O_5.2H_2O$(?)	Monoclinic(?)

A single specimen from Custer County contains a mineral which may be bayldonite although the identification is incomplete.

CUSTER COUNTY

A specimen of galena-tetrahedrite ore from the Ramshorn mine, Bayhorse district, contains a few small cavities lined with white cerusite crystals. On the cerusite rest minute acicular yellow prisms of mimetite, previously mentioned, and a large part of the mimetite prisms are coated or replaced by a lusterless mossy friable olive-green to yellow-green mineral. Under the microscope this green material is seen to be made up of aggregated minute grains and crystals of a transparent mineral of pale green nonpleochroic color and index of refraction very much above 1.82. Some of the grains show crystal outlines which appear as though they were short prisms with oblique terminations resting on the *b* pinacoid. These give optical properties apparently indicating the mineral to be biaxial positive with $2V$ large, dispersion $r>v$ weak. The extinction is inclined and the data obtained make the optical orientation $Z=b$, $Y: c=28°$. These data do not agree entirely with the optical orientation and dispersion given for bayldonite, but they are approximate only, owing to the nature of the material, and may be incorrect. The mineral gives an arsenic mirror when heated with charcoal in a closed tube.

EVANSITE (645)

Hydrous aluminium phosphate, $3Al_2O_3.P_2O_5.18H_2O$.	Amorphous.

Specimens sent to the United States Geological Survey by C. R. Potts from Goldburg in Custer County were identified as evansite and described by Dr. W. T. Schaller.[36]

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[36] Waldemar T. Schaller. U. S. Geol. Survey, Bull. 490, p. 91, 1911.

CUSTER COUNTY

The evansite from Goldburg is massive and amorphous and occurs in seams. It is brittle, with a conchoidal fracture and varies in color through shades of yellow, white, brown and dark red. The brown variety very much resembles common brown opal. An analysis of this brown variety gave the following results:

Analysis of evansite from Goldburg, Idaho

(W. T. Schaller, analyst)

	Per cent
Water (H_2O)	36. 96
Phosphoric acid (P_2O_5)	19. 14
Ferric iron (Fe_2O_3)	5. 49
Alumina (Al_2O_3)	34. 48
Lime CaO	4. 32
Magnesia (MgO)	Trace.
Ferrous iron (FeO)	None.
Total	100. 39

The temperatures at which the water content of the mineral is given off were determined and the following table shows the amount of water expelled at the several temperatures:

Loss of water of evansite from Idaho

	Per cent
At 107° C	20. 00
At 175° C	7. 36
At 255° C	3. 13
At 290° C	. 94
At low red heat	3. 90
At blasted	1. 61
Total	36. 94

A density determination by means of Thoulet solution of the relation of the density to the amount of iron present gave the following values:

Relation of density to iron content

Color of mineral	Fe^2O^3	Average density	Limits
Dark red	6. 60	2. 00	1. 990–2. 016
Brown	5. 49	1. 98	1. 972–1. 990
Yellow	2. 15	1. 94	1. 927–1. 947

By plotting these values it was found that the density of the mineral free from iron should be between 1.88 and 1.91, though this value does not necessarily represent that of pure evansite as the material on which these determinations were made contains considerable calcium.

A determination by F. E. Wright of the index of refraction of the colorless evansite from Idaho gave 1.485, the index for the colored varieties not varying more than 0.01 from this value.

BINDHEIMITE (670)

Hydrous lead antimonate, approximates
the formula $2PbO.Sb_2O_5.xH_2O$. Amorphous.

Bindheimite is a common mineral formed by the oxidation of antimonial sulphides in lead-bearing ore bodies. It is most frequently some shade of yellow in color, although other colored varieties are known, and in texture it varies from a soft friable pulverulent ocher to compact opaline material. The bindheimite, in some cases is the result of alteration of lead sulphantimonites, as boulangerite and jamesonite and then usually has a fibrous structure inherited from the parent mineral. It commonly results from the alteration of tetrahedrite-galena ores in which the antimony is furnished by the tetrahedrite and the lead by the galena. Most of the Idaho occurrences have had this origin. The occurrences which have been noted in the State are described separately below. It is noteworthy that bindheimite contains its antimony in a form very hard to reduce so that, by ordinary blowpipe methods, this element is very hard to detect and ocherous bindheimites from Idaho have previously been called massicot, in error, by the present writer as well as others. Massicot is not definitely known from the State. The pulverulent yellow bindheimite is commonly called "chlorides" by Idaho miners when yellow, or "bromides" when stained blue or green by copper.

BLAINE COUNTY

Bindheimite was probably common in oxidized lead-silver ores of the Wood River country and elsewhere in Blaine County. A specimen from the bins at the No. 2 tunnel of the Golden Glow mine in Boulder Basin contains bindheimite occurring sparingly as an alteration product of boulangerite.

CUSTER COUNTY

Bindheimite is common in the Bay Horse district in Custer County. A specimen from the Ramshorn mine contains yellow-green waxy bindheimite occurring with malachite and azurite as an oxidation product of tetrahedrite containing granular galena. A small amount of waxy yellow bindheimite occurs with cerusite and galena in quartz in a specimen from the River View mine. A yellow to greenish-yellow earthy pulverulent mineral associated with massive cerusite from the Cave mine is probably bindheimite. Yellow powdery masses of this mineral occur with malachite and anglesite as an alteration product of galena-tetrahedrite ore from the Hoosier group, above the Beardsley mill in the Bay Horse district, and compact waxy yellow material occurs sparingly in quartz with linarite in a specimen from the Pacific claim. Compact bindheimite, greenish from copper stain, associated with azurite and including residual tetrahedrite occurs in specimens from the Skylark mine.

OWYHEE COUNTY

Bindheimite has been noted in ore from the South Mountain district as an ocherous yellow powder in cavities of coarse galena with anglesite and linarite in the Monkey mine, with cerusite and anglesite coating coarse cleavable galena from the Rocksyfellow mine and sparingly as ocherous yellow stains with cerusite and minium on ore from the Golconda mine.

A rich silver ore from near the surface in the Castle Creek mine near the Dunham Ranch 18 miles from Oreana, consists of cavernous quartz containing pulverulent dull yellow material called "chlorides." This is completely soluble in hot concentrated hydrochloric acid and gives reactions for abundant antimony and lead, hence is doubtless bindheimite.

SHOSHONE COUNTY

In the Coeur d' Alene district bindheimite probably occurred in the oxidized portions of all of those mines which contain primary antimonial minerals. The oxidized ores of this district consisted for the most part of cerusite and limonite with smaller amounts of anglesite, pyromorphite, plattnerite, and native silver, A common constituent of the oxidized ores of all the larger mines of the region was a soft ocherous material of a canary yellow color which, except in its brighter tone of color, looked very much like the ocherous limonite which was abundant in the ores. The miners recognized this mineral and commonly referred to it as "chlorides" and regarded it as indicating rich silver values in the oxidized ore. Such soft yellow material was recognized by Ransome,[37] who thought it to be massicot and the present writer, even after having made blowpipe tests for antimony, called the material massicot and stated that bindheimite did not occur.[38] Later more thorough examination established the presence of abundant antimony in these materials. Hundreds of tons of ore in which bindheimite was a prominent constituent have been mined in the district.

In the Hercules mine the ocherous yellow lead antimonate was common in all of the richer ore associated with large masses of crystalline cerusite. It was also prominent in the surface ores of the Poorman mine at Burke and was conspicuous practically to the surface in some of the upper workings of this mine. In the upper workings of the Mammoth mine at Mace small cores of unoxidized tetrahedrite were surrounded by concentric rings of yellow and greenish-yellow bindheimite.

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[37] F. L. Ransome, and F. C. Calkins. U. S. Geol. Survey, Prof. Paper 62, p. 94, 1908.

[38] E. V. Shannon. Secondary enrichment in the Caledonia mine, Coeur d' Alene dist., Idaho Econ. Geology, vol. 8, p. 565, 1913.

In the Last Chance mine at Wardner much of the cerusite of the richest oxidized ore was dusted with bindheimite and in the adjoining Tyler mine this mineral was of frequent occurrence.

The Caledonia mine, west of Wardner, produced much ore in which the valuable metals were entirely in the form of bindheimite, masses of nearly pure friable bindheimite several feet in diameter being exposed at times in the oxidized ores and having the same attitude as masses of tetrahedrite in the unoxidized portions of the vein. Sulphantimonites other than tetrahedrite have not been noted in this mine and the bindheimite seems to represent a pseudomorph, in most cases, after tetrahedrite and to have formed by reaction between the lead in solution and the antimonial mineral in place. A reversal of this relation is shown by the occurrence of lumps of galena surrounded by crusts of bindheimite. Furthermore a single specimen of soft yellow bindheimite was obtained from the Caledonia mine which had the typical granular structure and traces of the cubic cleavage of galena.

A specimen of ore from the Northern Light mine on Pine Creek consists of quartz containing galena largely oxidized to greasy masses of cerusite. Vuggy portions contain a canary-yellow lusterless material which is friable and has an acicular structure pseudomorphous after some fibrous sulphide. This yellow material, which is doubtless bindheimite, is reduced on charcoal before the blowpipe to a black globule, whch reacts for lead and antimony. Under the microscope the mineral is transparent and isotropic with an index of refraction much higher than 1.84.

This mineral has been noted in specimens from the Lookout Mountain and Carbonate mines, on Pine Creek, and also in ore from the Hypotheek mine south of Kingston. A specimen of lusterless compact yellow bindheimite from the Hypotheek mine was analyzed with the following results:

Analyses of bindheimite from the Hypotheek mine

(E. V. Shannon, analyst)

	Per cent
Insoluble (quartz)	2. 28
Lead oxide (PbO)	53. 48
Antimony pentoxide (Sb_2O_5)	36. 54
Ferric iron oxide (Fe_2O_3)	3. 84
Carbon dioxide (CO_2)	. 60
Water above 110° C	3. 27
Water below 110° C	. 30
Total	100. 31

Assuming all the iron to be present as limonite and the carbon dioxide as cerusite this material may be interpreted as having the following mineralogical composition:

	Per cent
Limonite	4. 49
Cerusite	3. 64
Bindheimite	89. 83
Quartz	2. 28

The composition derived for the bindheimite, recalculated to 100 per cent, is as follows:

	Per cent
Lead oxide (PbO)	57. 32
Antimony oxide (Sb_2O_5)	41. 53
Water (H_2O)	1. 15
Total	100. 00

These percentages yield ratios approximating closely to the formula

$$2PbO.Sb_2O_5.\tfrac{1}{2}H_2O$$

The bindheimite usually seems to be a little less rich in silver than the tetrahedrite of the same mine. That from the Hypotheek mine is practically free from silver. Owing to its pulverulent and friable nature, much of the bindheimite of the Ceour d'Alene district is lost in handling the ore, practically all of it in any wet gravity concentration or washing. There is a belief among the miners that this mineral is very dangerous in causing "leading" or lead poisoning. The mineral can best be determined by solution in concentrated hydrochloric acid and saturation with hydrogen sulphide when red antimony sulphide is precipitated. Upon dilution with water the black lead sulphide is then precipitated.

SODA NITER (683)

Sodium nitrate, $NaNO_3$. Rhombohedral.

Soda niter has been found in small amounts in Elmore and Owyhee Counties in Idaho.

ELMORE COUNTY

Pure sodium nitrate occurs in thin scales and plates in the structure and shrinkage cracks of a 100-foot vertical bluff of recent black basalt near King Hill on the banks of the Snake River. This deposit has no commercial value and is regarded by Bell as due to leaching of the lava.[39]

OWYHEE COUNTY

Soda niter occurs in impure form in several places in Owyhee County southeast of Homedale, Oreg. At the Roosevelt claim, one-half mile below Huntley's ranch, impure soda niter occurs as a constituent of crusts of salts which contain also niter, epsomite, and halite, all stained red by iron oxide. At the Abbie claim in the same vicinity thin seams of crystalline salts occupying cracks in rhyolite consist of soda niter, niter, epsomite, and mirabilite. On the Dorothy claim the soda niter occurs with mirabilite and epsomite in veinlets 3 to 5 mm. thick in rhyolite and it is also abundant in the surface soils. On Jump Creek, 10 miles east of Sucker Creek, soda niter occurs similarly with epsomite and mirabilite in crevices.[40]

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[39] Robert N. Bell. Ann. Rept. State Mine Inspector. Mining Industry of Idaho for 1913, p. 211.

NITER (684)

POTASH NITER, SALTPETER

Potassium nitrate, KNO_3. Orthorhombic.

Niter has been found in small amounts in soils and in cracks in lavas in several places in Idaho and some saline claims have been located and some work done. The deposits all appear to be very superficial and of small extent and the niter probably is nowhere present in commercially valuable amount.

BLAINE COUNTY

In Blaine County, 9 miles east of Soldier, niter occurs in depressions or small cavities in rhyolite, and also impregnating soil at the bases of cliffs. The material, which is said to be present in considerable quantity, is essentially potassium nitrate with a little soda and lime in some samples.[41]

CLARK COUNTY

Specimens of crystalline granular niter collected by H. T. Stearns of the United States Geological Survey have been examined. These were collected from cracks and crevices in basalt at the backs of lava tunnels near the United States Sheep Experimental Station, 6 miles northeast of Dubois. When the niter is removed the cracks fill up again in the course of a year or two. The niter is white and crystalline-granular and does not alter on exposure to air. Under the microscope it is homogeneous with the usual optical properties. An analysis gave the following results.

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[40] G. R. Mansfield. U. S. Geol. Survey, Bull. 620, p. 19, 1916.

[41] G. R. Mansfield. U. S. Geol. Survey, Bull. 620, p. 28, 1916.

Analysis of niter from near Dubois, Idaho

(E. V. Shannon, analyst)

	Per cent
Insoluble in water	0.24
Alumina and ferric iron	Trace.
Water (below fusion)	.12
Lime	None.
Potassium nitrate (KNO_3)	98.74
Sodium nitrate ($NaNO_3$)	1.74
Total	100.84

The results indicate an unusually pure salt.

ELMORE COUNTY

Niter has been found in cavities and cellular material in volcanic tuff at a locality 30 miles north of King Hill near Camas Prairie.[42]

OWYHEE COUNTY

Niter has been found in several places southwest of Homedale in Oregon and probably occurs in similar deposits in shelly rhyolite in Owyhee County.

LUDWIGITE (694)

Iron-magnesium borate, $3MgO.B_2O_3$, $(Mg, Fe)O.Fe_2O_3$. Orthorhombic.

The rather rare iron and magnesium borate, which occurs in the copper ore deposit of the Bruce Estate in the Texas district in Lemhi County south of Dry Gulch, has already been described.[43] The essential features of the description are repeated here.

LEMHI COUNTY

The ludwigite was identified as the most abundant constituent of a specimen from the Bruce Estate copper prospect. It forms fairly pure masses up to some 10 cm. in diameter, which contain disseminated grains of diopside and irregular patches of bornite, and also occurs in disseminated form intergrown with bornite and chalcopyrite as a replacement of calcite of a calcite-diopside rock. The prospect from which the mineral came occurs in limestone at the side of a large dike of quartz-diorite and the ludwigite is a metamorphic mineral resulting from the action of the emanations accompanying the diorite intrusion on the adjacent limestone.

The mineral is black in the hand specimen and has a very finely felted structure in which the fibrous texture is too fine to be conspicuous to the unaided eye, but is manifested by a faint silky luster which might easily be overlooked and then the mineral might be mistaken for magnetite. The hardness is above 5 as the ludwigite scratches apatite but is itself scratched by orthoclase. It is not attracted by a common magnet. In thin fragments it is transparent and very pleochroic in tones of brown parallel to the elongation of the fibers and green perpendicular to them. The absorption is greatest in the direction of elongation and the extinction is parallel. The birefringence is moderate while the indices of refraction are high. The ludwigite yields a small amount of adsorbed water in the closed tube and is slowly soluble in nitric, hydrochloric, and sulphuric acids. When moistened with sulphuric acid it gives the green flame of boron. A selected sample of the purest material upon analysis gave the following results.

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[42] Robert N. Bell. Ann. Rept. State Inspector of Mines, Mining Industry of Idaho for 1913, p. 211.

[43] Earl V. Shannon. Ludwigites from Idaho and Korea. Proc. U. S. National Museum, vol. 59, pp 667-669.

Analysis of ludwigite from Lemhi County, Idaho

(E. V. Shannon, analyst)

	Per cent
Silica (SiO_2)	0. 90
Ferric iron (Fe_2O_3)	35. 90
Alumina (Al_2O_3)	2. 08
Ferrous oxide (FeO)	5. 14
Magnesia (MgO)	36. 42
Lime (CaO)	Trace.
Manganous oxide (MnO)	Trace.
Copper oxide (CuO)	2. 87
Boric anhydride (B_2O_3)	14. 59
Water (H_2O) above 105°C	2. 28
Water (H_2O) below 105°C	. 03
Sulphur (S)	. 22
Total	100. 42

The sulphur, copper, silica, and water are probably present as extraneous materials, the sulphur and a part of the copper as bornite, the silica as diopside, and the water adsorbed. After deducting these the remaining constituents give the following ratios:

FeO	0. 072	0. 975	1. 08×4
MgO	. 903		
Fe_2O_3	. 225	. 225	1. 00×1
Al_2O_3	. 020	. 229	1. 02×1
B_2O_3	. 208		

These ratios give the general formula:

$$4\ (Mg,Fe)O.Fe_2O_3.B_2O_3,$$

or an isomorphous mixture of ferroludwigite and magnesioludwigite in the ratio of 3 to 7. The essential constituents shown by the analysis are reclaculated to 100 per cent and below compared with the theoretical composition of a mixture of 7 parts of magnesioludwigite and 3 parts of ferroludwigite.

Recalculated analysis of ludwigite

	Analysis recalculated	Theory
MgO	38.69	37.26
FeO	5.46	5.38
Al_2O_3 2.21	17.71	17.48
B_2O_3 15.50		
Fe_2O_3	38.14	39.88
Total	100.00	100.00

The occurrence of the ludwigite has not been studied at the locality, the mineral having been first identified in a specimen in the National Museum.

BARITE (719)

BARYTES, HEAVY SPAR

Barium sulphate, $BaSO_4$. Orthorhombic.

The following localities for the mineral barite have been noted in Idaho. The only one having any prospective commercial importance is in Blaine County. The mineral has a limited market, being used in the manufacture of paint pigments and barium chemicals.

ADAMS COUNTY

In the Red Ledge mine in the Seven Devils district barite is an important gangue mineral and a constant associate of the highest grade ore. A typical lot of ore had a total insoluble residue of 32 per cent, 21 per cent of which was barite.[44]

BLAINE COUNTY

A remarkable deposit of barite was discovered at the head of Deer Creek 9 miles north-northwest of Hailey and about 7 miles from the railroad at the mouth of Deer Creek, by Prof. L. G. Westgate, of the United States Geological Survey. This is a lenslike mass 50 feet, thick and 1,000 feet long lying apparently conformably with the Pennsylvanian quartzites and calcareous sandstones of the region which strike north 50° west and dip 55° northeast. It crops out 1,400 feet above Deer Creek Valley at an altitude of 7,400 feet. The whole body is composed of white crystalline barite marked with brownish bands.[45]

BOISE COUNTY

Barite has been noted in small amount in a specimen of gold ore from the Carroll-Driscoll mine in the Quartzburg district. The specimen is a rounded nodule from a sericite gouge and consists of quartz containing a peculiar grayish purple mineral which was identified as barite by its optical properties and blowpipe reactions. It is associated with sulphides, including pyrite, sphalerite, tetrahedrite, and galena.

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[44] D. C. Livingston and F. B. Laney. Idaho Bur. Mines and Geol., Bull. 1, p. 52, 1920.

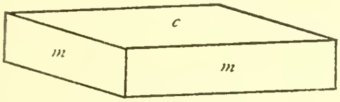
[45] U. S. Geol. Survey, Mineral Resources of United States, 1915, pt. 2, p. 172.

CASSIA COUNTY

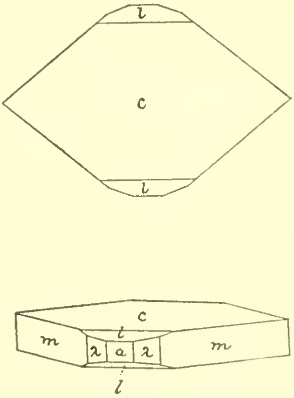
Barite occurs with scorodite and cinnabar as the principal gangue mineral in cinnabar prospects in the Black Pine district in Cassia County. The barite forms porous aggregates of tabular white crystals of very simple habit bounded only by the base and unit prism, as shown in Figure 144. Some of the rough crystals which are buff-stained reach 3 cm. in diameter.[46]

CUSTER COUNTY

Barite has been reported to occur as a gangue mineral in small amount in the Lost Packer mine in the Loon Creek district. Minute white crystals of barite rest on pyrite lining cavities in an aggregate of pyrite and bismuthinite from the Empire ledge in Washington Basin.



144



145

FIGS. 144-145.—144, BARITE, BLACK PINE QUICKSILVER MINE, CASSIA COUNTY. 145, BARITE, DELAMAR MINE, OWYHEE COUNTY

FREMONT COUNTY

Barite occurs as bunches scattered through the brown jaspery material of the ore of the Weimer copper mine in the Skull Canyon district.[47] A specimen from this mine contains platy white barite inclosing chalcopyrite.

LEMHI COUNTY

Barite is intergrown with quartz in one of the gold veins at Mineral Hill and occurs also as a gangue mineral in two deposits of lead-silver ore at Spring Mountain. It is nowhere abundant.[48]

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[46] E. S. Larsen. Univ. of Idaho Sch. of Mines, Bull. 2, pp. 65-67, 1920.

[47] J. B. Umpleby. U. S. Geol. Survey, Prof. Paper 97, p. 112, 1917.

[48] J. B. Umpleby. U. S. Geol. Survey, Bull. 528, p. 75, 1913.

OWYHEE COUNTY

Barite has been found in the De Lamar mine in small bunches in kaolin in the Silver City district.[49] On one large nodular mass of naumannite previously described from this mine a small cavity was lined with minute tabular crystals of barite. These had the form and habit shown in Figure 145, the forms being *c*(001) and *m*(110) with smaller faces of *a*(100), (210), and *l*(104). The identity of the material was established by both crystallographic and optical measurements.

SHOSHONE COUNTY

Barite has been found at a number of places in the Coeur d'Alene district. In the Mullan area it occurs in several mines, among them the Morning, Gold Hunter, Carney Copper, Little Giant, and probably others. In places in the Gold Hunter mine barite is abundant in fine-granular white masses carrying thin sheets of galena, sphalerite, and tetrahedrite, which give the ore a striking banded appearance. More coarsely crystalline barite was found in some of the upper workings, and the mineral occurs in seams in the country rock.

In the Carney Copper mine barite occurs as veins in places 4 feet wide. It is fine grained and commonly shows banded structure with the development of small pyrite crystals.

In the Morning mine barite occurs locally in irregular bands which may be 1 foot thick.

Barite and galena occur in the Little Giant prospect south of Mullan on Silver Creek.

Barium has been reported to have been found by analysis in ores from the Standard-Mammoth mine, although no specimens of barite have been seen from this mine.

Barite has been found in occasional masses in several of the lead-silver mines east of Wardner. This mineral formed a small vein with galena in the Senator Stewart mine and has been reported to have been found in the Crown Point and Silver King mines in Government Gulch. In the Caledonia mine a large mass of coarse-cleavable white barite was encountered in a tetrahedrite ore-shoot on the first floor above the 900 foot level in 1915.

ANGLESITE (721)

Lead sulphate, $PbSO_4$. Orthorhombic.

Angelsite is usually the first mineral formed by the breaking down of galena under the influence of oxidation. It very frequently occurs surrounding lumps of galena or inserted between the core of parent galena and an outer crust of cerusite. Such anglesite is usually fine compact massive and has a characteristic ashy gray color. The mineral more rarely occurs as transparent glassy crystals which greatly resemble cerusite crystals, although they may be distinguished by their lack of twinning. In Idaho compact massive or earthy anglesite has been found in a number of districts and finely crystallized specimens have come from the Coeur d'Alene district in Shoshone County.

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[49] Waldemar Lindgren. U. S. Geol. Survey, 20th Ann. Rept., pt. 3, p. 170, 1900.

BLAINE COUNTY

The earthy forms of anglesite are commonly present in the upper portions of lead-bearing veins. They have often been reported from the Wood River district and also from the districts of the Sawtooth quadrangle. A specimen from the No. 3 ore shoot of the Golden Glow mine consists of heavy massive ash-gray anglesite.

CUSTER COUNTY

Earthy or massive anglesite occurs in Custer County in practically all of the lead-silver deposits. Masses of this material inclosing residual galena have been examined from the Hoosier and Cave mines in the Bay Horse district.

ELMORE COUNTY

Anglesite has been noted as minute white crystals in little cavities in galena which is associated with pyrargyrite and stephanite in rich silver ore from the Atlanta Lode, Atlanta district.

FREMONT COUNTY

In the Wilbert mine, Dome district, the ore consists of disseminated galena now mostly altered to anglesite, scattered through light-gray quartzite. In places this gives way to thin lenses and stringers of anglesite and galena. The mineralogy of the ore is simple, galena and its oxidation products, anglesite and cerusite, being the only abundant minerals. The galena is the dense variety known as steel galena and the oxidation products are similarly fine-grained.[50]

Gray greasy-lustered massive anglesite surrounds cores of fine grained galena in specimens from the Weimer copper mine in the Skull Canyon district.

LEMHI COUNTY

Anglesite occurs sparingly in ores of the Texas, Junction, and other districts. It is nowhere abundant. Pure heavy massive ash gray specimens have been seen from the Latest Out mine in the Texas district.

OWYHEE COUNTY

Anglesite is present in a number of ores from old mines in Owyhee County. Specimens from the Rocksyfellow mine in the South Mountain district consist of coarse grained galena coated with earthy anglesite, cerusite, and bindheimite. A specimen from the Monkey mine, in the same district, also consists of coarse galena altering to an outer crust of compact ash-gray anglesite preserving the cubic lines of the galena. Linarite and bindheimite coat the anglesite. Specimens from the Leviathan mine, Flint district, show the usual gray crust of anglesite on coarse galena.

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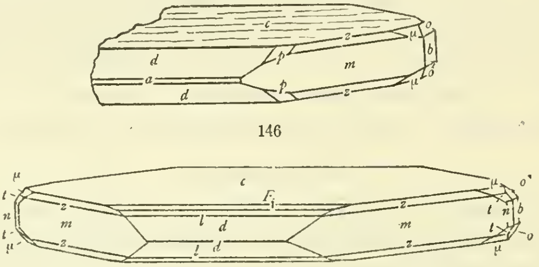
[50] J. B. Umpleby. U. S. Geol. Survey, Prof. Paper 97, p. 117, 1917.



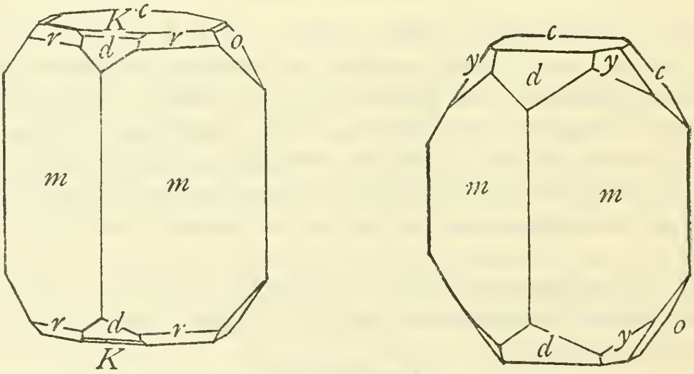
146

147

Figs. 146–147.—Anglesite crystals from Hercules mine, Shoshone County

SHOSHONE COUNTY

Anglesite has been noted in five mines in the Coeur d'Alene district but, considering the amounts of galena and cerusite which have been mined in the district, the anglesite is unusually rare.



148

149

Figs. 148–149.—Anglesite crystals. Hypotheek mine, Shoshone County

The sulphate has not been identified from the Hercules mine except in a single specimen in the National Museum which has been described.[51] The specimen which is labeled "Ore, native silver," is a mixture of earthy limonite with massive anglesite looking precisely like the majority of specimens of carbonate lead ore. Implanted upon this earthy mass are numerous well-defined transparent anglesite crystals. Over the anglesite crystals are strung dendritic crystalline wires of native silver, now entirely blackened exteriorly by a tarnish of silver sulphide.

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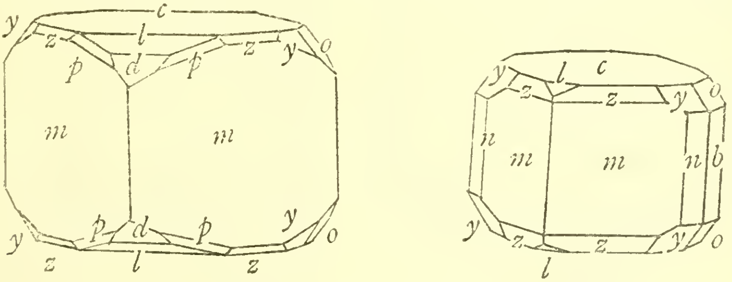
[51] Earl V. Shannon. Proc. U. S. Nat. Mus., vol. 58, p. 441–442, 1920. Anglesite crystals from the Hercules mine, Coeur d' Alene district, Idaho.

The crystals are tabular in development the shape being determined by the forms *c*(001), *m*(110), and *d*(102). They reach an extreme length of 2 cm., although the average is about 3 mm., with a thickness of 1 mm. The habit is illustrated in the drawings, Figures 146 and 147. As accessory forms there are small faces of *a*(100), *b*(010), *z*(111), *o*(011), (124) *p*(324), *n*(120), *t*(121), *l*(104), and one new form, a dome, lettered F_1 which gives the indices (1–0–14). This was observed only once as a line face yielding a poor signal. It gave the following angles:

Angles of new form F_1 (1–0–14)

Letter	Gdt.	Miller	Quality	Measured	Calculated
				° ′ ° ′	° ′ ° ′
F_1	$\frac{1}{14}$ 0	1. 0. 14	Medium, poor	90 00 6 55	90 00 6 41



150 151

FIGS. 150–151.—ANGLESITE. HYPOTHEEK MINE, SHOSHONE COUNTY

In the Last Chance mine prismatic flattened crystals, elongated on the *b* axis were occasionally found in cavities in galena, although in many specimens there was no anglesite but instead clear cerusite crystals resting on the unaltered galena. Some of the anglesite crystals reached an extreme length of 5 cm., their habit being similar to Figure 153. These were commonly smoky gray to black from included unoxidized galena.

In the adjacent Tyler mine anglesite was frequently found in cavities in galena and associated with decomposing pyrite. Most of the crystals from this mine were extremely simple many of them simply consisting of the unit prism *m*(110) and the base *c*(001), although small faces of the domes *o*(011) and *d*(102) usually occurred. Often vertically elongated crystals showed notched edges due to parallel growth (*o*). A crystal from this locality, now in the Brush collection, of rhombohedral aspect showing *m* and *c* with minute faces of *o* is perfect in form and transparency and about 1 cm. in diameter. Frequently the crystals from this mine are coated on the prism and pinacoid faces with limonite while the domes are clear and brilliant.

In the Highland-Surprise mine anglesite occurred in specimens from the Highland-Chief tunnel as a compact ash-grey coating around lumps of galena, the anglesite in turn being coated with limonite.

The Hypotheek mine near Kingston has produced the finest crystals of anglesite that have been found in the State. Indeed it is doubtful whether any locality in the United States has surpassed this locality in the size and beauty of its crystals. The ores of the mine are oxidized to an unusual depth and consist largely of cerusite. Large bunches of pure granular galena occur surrounded by soft ocherous material, which consists mainly of oxides of iron and manganese, and contains bunches of cerusite, malachite, covellite, bindheimite, etc. It is in cavities in the residual lumps of galena that the fine anglesite crystals occur. These crystals are colorless, perfectly transparent, and exceedingly brilliant. The crystals examined by the writer, and described in a previous paper,[52] were obtained in September, 1916, from a small mine car of ore beneath the surface bins. This ore had been shot down, shoveled into a chute, and probably handled a half dozen times through cars and bins, yet after this prolonged abuse the protected cavities and interiors of the lumps contained crystals equal to the finest specimens from Sardinia at present visible in American collections. In the possession of Thomas Strick, a foreman at the mine, was seen a lump of galena having a cavity several inches across lined with ideally perfect doubly terminated crystals an inch or more in length having the form shown in Figure 152. Two smaller specimens from the same cavity were obtained at the time. One of these is now in the collection

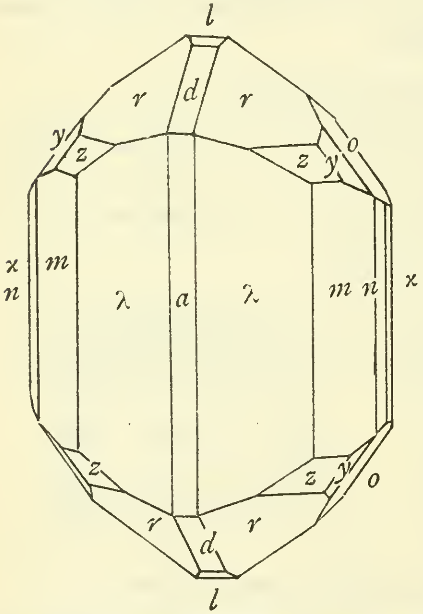


FIG. 152.—ANGLESITE. HYPOTHEEK MINE, SHOSHONE COUNTY

of Col. W. A. Roebling. In commenting upon the latter specimen, Colonel Roebling writes as follows: "Although I have at least 30 anglesites, the crystal you sent is the best of its class * * *. The Broken Hill specimens are different in habit and more orange in color * * *. Yours is like those from Monte Poni, Sardinia, embedded in galena, frequently with a black heart of unchanged galena. Occasionally there has been too much sulphur for the lead to absorb, leaving a cavity with a perfect little crystal of sulphur in it."

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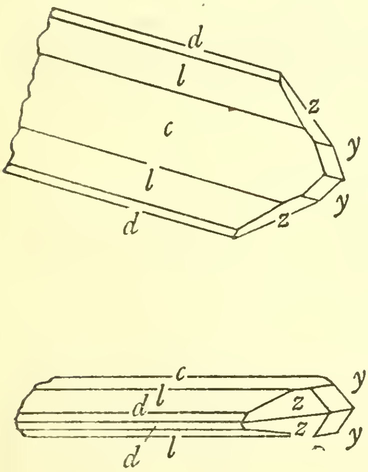
[52] Earl V. Shannon. Anglesite from the Coeur d' Alene district, Idaho. Amer. Journ. Sci., vol. 47, pp. 287-292, 1919.



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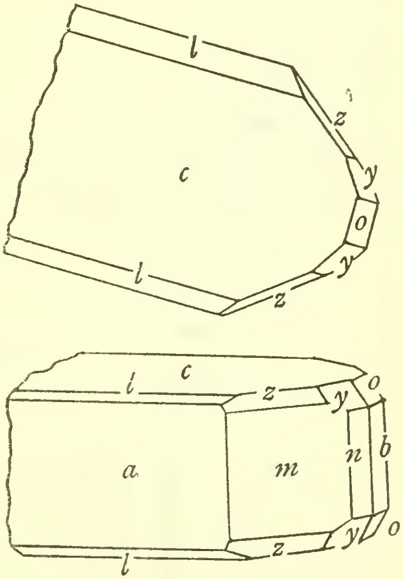


154

FIGS. 153–154.—ANGLESITE. HYPOTHEEK MINE, SHOSHONE COUNTY

The largest crystal observed at the mine was about 4 cm. in diameter, but some as large as an egg are said to be frequently obtained. Cavities lined with crystals up to 1 cm. in diameter occur everywhere in the galena. Where a little work with a hack saw and a light hammer would yield a beautiful specimen, the lumps of galena are struck, by the miners, with a heavy hammer. If a fairly symmetrical group of crystals breaks out it is preserved, but when, as commonly happens, the anglesite flies to pieces or the crystals break loose from the matrix, the whole is thrown away.

These crystals from the Hypotheek mine are ideally suited for measurement on the reflecting goniometer. The accompanying Figures 148 to 156 show the predominant habits observed. The first 10 examined and described in the paper cited were measured on the one-circle goniometer. On these the following forms were observed:

a (100)
b (010)
c (001)
m (110)
n (120)
κ (130)
λ (210)
New (910)
r (112)
z (111)
y (122)
p (324)
τ (221)
l (104)
K (106)
d (102)
o (011)
New (0.1.14)
s (132)

Of these two forms (910) and (0.1.14) are new. The angles measured for them on the 1-circle goniometer compare as follows with the calculated angles:

	Calculated		Measured	
	°	′	°	′
$0.1.14 : 0.\bar{1}.14$	10	38	10	36
$910 : 9\bar{1}0$	9	58	9	40

More recently a few crystals from the locality have been measured on the 2-circle goniometer. The drawings, Figures 155–156, have been made from these measurements. The average angles obtained are given in the following table:

Measurements of anglesite from the Hypotheek mine

Form		Symbol		Quality, description	Measured		Calculated	
No.	Letter	Gdt.	Miller		φ	ρ	φ	ρ
					° ′	° ′	° ′	° ′
1	*c*	0	001	Excellent	-- --	0 00	-- --	0 00
2	*b*	0∞	010	Narrow, poor	0 00	90 00	0 00	90 00
3	*a*	$\infty 0$	100	Very poor, striated	90 00	90 00	90 00	90 00
4	*m*	∞	110	Excellent	51 51	90 00	51 51	90 00
5	*n*	$\infty 2$	120	Fair	32 20	90 00	32 29	90 00
6	κ	$\infty\frac{3}{8}$	130	Excellent	22 52	90 00	23 00	90 00
7	*V*	$\infty\frac{8}{5}$	580	Medium	37 37	90 00	38 31	90 00
8	α	$0\frac{1}{8}$	018	Poor	0 00	8 23	0 00	9 09
9	New	$0\frac{1}{13}$	0. 1. 13	Medium	0 00	5 38	0 00	5 40
10	*o*	01	011	Excellent	0 00	52 10	0 00	52 12
11	*F*	$\frac{1}{15}\ 0$	1. 0. 15	Poor	90 00	7 07	90 00	6 15
12	*l*	$\frac{1}{4}\ 0$	104	Very good	90 00	22 02	90 00	22 19
13	*d*	$\frac{1}{2}\ 0$	102	Excellent	90 00	39 13	90 00	39 23
14	*f*	$\frac{1}{4}$	114	Very good	51 25	28 43	51 51	27 34
15	*r*	$\frac{1}{2}$	112	Medium	51 34	46 13	51 51	46 14
16	*z*	1	111	do	51 34	64 24	51 51	64 24
17	τ	2	221	Very poor	52 02	71 --	51 51	76 32
18	*t*	12	121	do	32 08	71 40	32 29	71 53
19	*y*	$\frac{1}{2}\ 1$	122	Medium	32 08	56 56	32 29	56 48
20	ι	$\frac{2}{3}\ 1$	233	Very poor	44 09	60 25	40 20	59 24
21	New	$\frac{2}{5}\ \frac{3}{5}$	235	Poor	38 58	45 21	40 20	45 25
22	*P*	$\frac{3}{4}\ \frac{1}{2}$	324	Good	62 47	54 16	62 22	54 16
23	New	$\frac{1}{4}\ \frac{1}{6}$	3. 2. 12	Poor	61 56	24 20	62 22	24 51
24	New	$\frac{3}{4}\ 1$	344	do	44 42	58 49	43 41	60 43

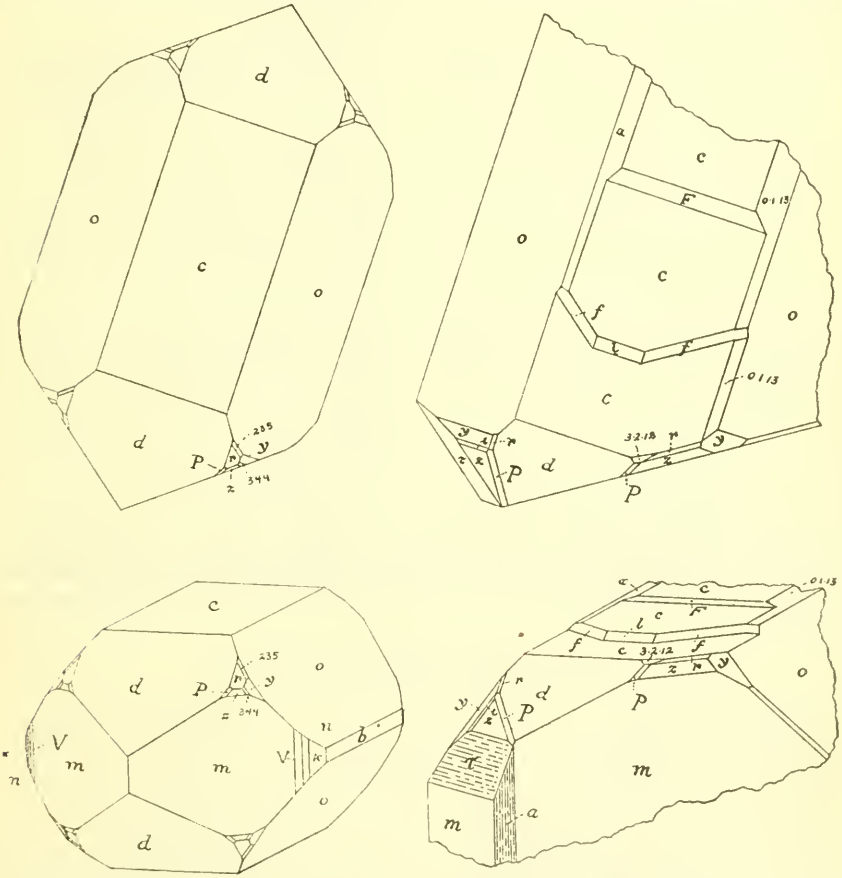
LEADHILLITE (734)

Sulphate-carbonate of lead, $4PbO.SO_3.2CO_2.H_2O$. Monoclinic.

Leadhillite has been identified in small amount in specimens from two mines in Shoshone County. It is probably present more frequently in the ores but has been overlooked because of its resemblance to cerusite.

SHOSHONE COUNTY

A specimen from the Caledonia mine has previously been described[53] as consisting chiefly of massive cerusite bearing on its surface ocherous limonite, drusy crusts of linarite, stains, and crusts of caledonite (?) and irregular masses of a greenish to brownish-white mineral. The latter mineral is altered and etched on the outside and resembles cerusite except that where broken open the masses show very perfect cleavage in one direction with pearly luster on the cleavage face. Before the blowpipe on charcoal with sodium carbonate the mineral gives a lead oxide coating and a button of metallic lead. It is soluble in hot hydrochloric acid with evolution of carbon dioxide and the solution reacts for sulphuric acid with barium chloride. The perfect basal cleavage makes it an easy


d
o
c
o
d
P
r
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y
344
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a
c
F
0.1.13
o
c
f
o
l
f
0.1.13
c
3.2.12
r
y
y
l
r
z
z
P
d
P
c
d
P
r
235
y
o
z 344
n
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n
o
d
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c
0.1.13
c
F
l
f
c 3.2.12
f
z
r
y
o
r
d
y
P
P
z
l
x
m
a
m

155 156

FIGS. 155–156.—ANGLESITE. HYPOTHEEK MINE, SHOSHONE COUNTY matter to obtain thin oriented plates of the mineral by crushing a fragment on a slide when thin plates lying on the cleavage are found to give a perfectly centered biaxial negative figure with 2E very small. The index of refraction and birefringence are high. These properties definitely identify the mineral as leadhillite.

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[53] Earl V. Shannon. Linarite and Leadhillite from Idaho. American Mineralogist, vol. 4, p. 94, 1919.

Leadhillite has also been identified in minute tabular crystals in a specimen from the Lookout Mountain mine east of the Forks of Pine Creek. The specimen is a residual lump of medium grained galena containing a little chalcopyrite. It is crusted with alteration products, which include cerusite, limonite, chrysocolla, copper pitch, linarite, caledonite, and the leadhillite. The leadhillite forms small tabular crystals of hexagonal aspect, most of which are now coated with or replaced by cerusite. A few were transparent and unaltered and one of these which was measured had the development illustrated in the drawing (fig. 157) and gave the following angles:

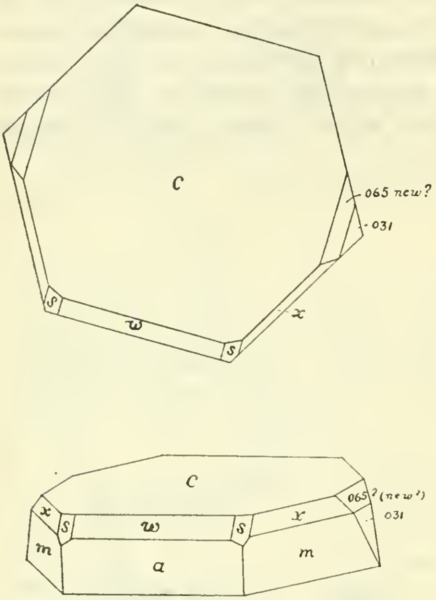

Fig. 157.—Leadhillite. Lookout Mountain mine, Pine Creek, Shoshone County

Measurements of Leadhillite, Lookout mine

Form		Symbol		Quality, description	Measured				Calculated			
No.	Letter	Gdt.	Miller		φ		ρ		φ		ρ	
					°	′	°	′	°	′	°	′
1	*c*	0	001	Dull, poor	--	--	0	00	--	--	0	12
2	*a*	∞0	100	Fair	90	00	90	00	90	00	90	00
3	*m*	∞2	120	Good	29	48	90	00	29	47	90	00
4	*w*	10	101	Very poor	90	00	52	13	90	00	52	13
5	(?)	03	031(?)	Poor, blurred	7	11	74	24	0	00	75	16
6	(?)	$0\frac{6}{5}$	065(?)	Excellent sig	6	00	53	20	0	00	53	04
7	*x*	12	121	Good	29	48	68	40	29	51	68	37
8	*s*	1½	212	Very poor	66	12	53	30	66	27	54	12

The measured crystal was examined under the microscope and found to be biaxial negative with 2E very small, birefringence high. The axial plane is parallel to the face adopted as *a*(100) and the acute bisectrix perpendicular to (001) which makes the optical orientation Y=*a*, Z=*b*, X=*c*. Dispersion $r<v$ inclined marked.

The mineral is partially soluble in concentrated hydrochloric acid with evolution of carbon dioxide. There is no doubt as to its identity as leadhillite.

CALEDONITE (739)

Basic sulphate of lead and copper, $4PbO.2CuO.3SO_3.3H_2O$. Orthorhombic.

Caledonite probably occurs in a number of places in the State, and has been tentatively identified on specimens from several localities. In all of these the material thought to be caledonite is present in small amount and the identification was in no case positively established.

CUSTER COUNTY

Caledonite was doubtfully identified as a minutely crystalline crust on malachite in oxidizing galena-tetrahedrite ore from the Hoosier mine in the Bay Horse district.

FREMONT COUNTY

Some very minute blue-green crystals, entirely too small for measurement, occurring with linarite in a specimen from the Wilbur mine in the Dome district are probably caledonite.

OWYHEE COUNTY

A specimen of oxidized lead ore from the Laxley mine, South Mountain district (Cat. No. 5459 U.S.N.M.) contains a pale green mineral which is probably caledonite associated with linarite and cerusite. The caledonite forms minute waxy globules, a part of which have a crystalline surface like the globules obtained by fusing pyromorphite.

SHOSHONE COUNTY

Thin pale green coatings which are not carbonate and are probably caledonite occur in small amount with linarite and leadhillite on a specimen from the Caledonia mine. Blue-green friable masses of microscopic crystals occur intermixed with linarite which coats galena in a specimen from the Lookout Mountain mine on Pine Creek. The material is in amount too small and is too mixed with linarite and cerusite to permit material to be isolated for chemical testing. Under the microscope these minute crystals are tabular rectangles with truncated corners. These give parallel extinction with the obtuse bisectix perpendicular to the flat side and negative elongation. They are biaxial negative then with 2V large. Assuming the optical orientation given for caledonite by Larsen they are tabular to *c*(001) and elongated on the *b* axis while the corners are truncated by faces of *m*(110). Measurement under the microscope of the angle between two of these truncating faces gave 84° which compares well with the angle of the prism, 85° 0′, of caledonite.

The lowest index, 1.818, is also that of linarite, while the other indices are much higher than 1.82, the highest immersion oil available. Under the microscope the mineral is pale green and no pleochroism could be noticed.

BROCHANTITE (740)

Basic copper sulphate, $4CuO.SO_3.3H_2O$. Orthorhombic.

The basic copper sulphate brochantite greatly resembles malachite in color and general appearance and may frequently be confused with the carbonate. It has been definitely identified in Idaho in the localities mentioned below and probably occurs elsewhere.

ADAMS COUNTY

The first recognition of brochantite in Idaho was by Palache,[54] who noted it in specimens from the Seven Devils district as slender transparent emerald-green prisms and radiating fibrous aggregates interspersed among epidote crystals. A number of specimens of this mineral from this district have been seen. A specimen from the Badger claim contains the basic sulphate as green crystalline films on joints and fractures. The specimen contains no measurable crystals. A specimen from the South Peacock mine contains small emerald green crystals in cavities in a mass of quartz and specularite. These are short prisms showing the prism $m(110)$ and the pinacoid $b(010)$. The terminations are dull and show no faces. Measurements of the prism zone give an angle of 75° 39′ for the prism which agrees with the angle $m:m'''$ for brochantite which is 75° 28′. The mineral dissolves in hydrochloric acid without effervescence and reacts strongly for sulphate with barium chloride.

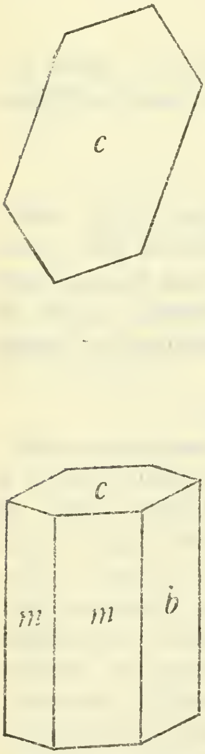

Fig. 158.—Brochantite. Pocatello, Bannock County

BANNOCK COUNTY

A specimen in the National Museum (Cat. No. 75521) labeled as from Pocatello, Bannock County, consists of chalcocite partly altered to an emerald green mineral, in a chalky-appearing whitish rock. The green material is brochantite. A small crystal from this locality which was measured was bounded by the prism $m(110)$, the pinacoid $b(010)$ and the base $c(001)$ which was dull, with the habit shown in Figure 158. The angle for the prism average 76° 20′ while the corresponding angle for brochantite is 75° 28′.

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[54] Charles Palache. Amer. Journ. Sci., vol. 8, p. 302, 1899.

Optically it was found that this mineral is biaxial negative with 2V large, dispersion $r<v$, large. Color green and nonpleochroic. Extinction parallel. There is a good cleavage parallel to the obtuse bisectrix or parallel to (001). The indices measured are $\alpha=1.727$, $\beta=1.778$. The higher index was higher than the highest oil available at the time the measurements were made.

CUSTER COUNTY

In the Alder Creek district (Mackay) brochantite is almost as abundant as malachite with which it is often intergrown. In a few specimens the brochantite is intergrown with azurite affording a beautiful blending of blue and green colors. Rarely it is crystallized in short stout rhombic prisms which are vertically striated. In places in the 300-foot Empire tunnel it forms the central portion of narrow veins of azurite in limestone.[55]

Brochantite has also been noted as crusts of minute emerald green crystals lining cracks in iron-stained rock in specimens from the Parallel tunnel, Parallel claim, Reed and Davidson mine, in the Copper Basin district, at the head of the east fork of Big Lost River.

LINARITE (741)

Basic sulphate of lead and copper, Monoclinic.
$PbO.CuO.SO_3.H_2O$.

The rare blue monoclinic double sulphate of copper and lead occurs occasionally in oxidized ores where lead, copper, and sulphuric acid have been available during oxidation. It usually forms small drusy or columnar masses closely resembling azurite. Compared with azurite, however, the color is a brighter blue and the luster of the linarite is more brilliant than that of azurite. The following localities in Idaho have been noted:

CUSTER COUNTY

A specimen from the Pacific mine, Bay Horse district, Custer County, consists of white quartz containing disseminated galena and tetrahedrite partly oxidized to waxy compact bindheimite and fine blue linarite. Space for the formation of well-bounded linarite crystals has been lacking but a few euhedral individuals occur in minute vugs. Only one crystal could be secured from the small specimen for measurement. The development assumed is shown in Figure 159. The forms and angles measured are as follows:

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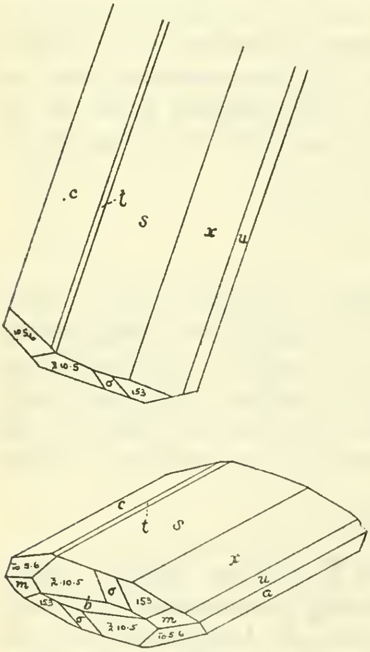
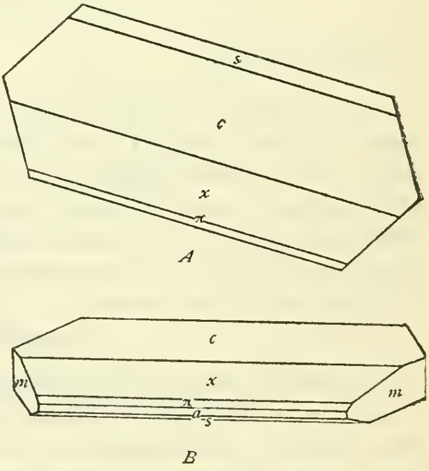
[55] J. B. Umpleby. U. S. Geol., Survey, Prof. Paper 97, p. 50, 1917.

Measurements of linarite from Pacific mine, Custer County

Form		Symbol		Quality, description	Measured				Calculated			
No.	Letter	Gdt.	Miller		φ		ρ		φ		ρ	
					°	′	°	′	°	′	°	′
1	*s*	0	001	Very good	90	07	15	15	90	00	15	11
2	*b*	0∞	010	Very poor	5	23	93	04	0	00	90	00
3	s	∞0	100	Narrow, blurred	90	02	90	00	90	00	90	00
4	*m*	∞	110	Good	30	55	90	00	30	50	90	00
5	*a*	02	021	do	8	56	60	51	9	17	59	15
6	*u*	+10	101	Very poor	90	07	34	36	90	00	37	29
7	*x*	$+\frac{1}{2}0$	102	Good	90	07	27	47	90	00	27	26
8	*t*	$-\frac{1}{6}0$	$\bar{1}06$	Very poor	90	07	10	07	90	00	10	41
9	*c*	−10	$\bar{1}01$	Good	90	07	12	18	90	00	12	37
10	(?)	$-\frac{4}{5}3$	$\bar{4}.5.15$	do	$\bar{3}$	46	67	07	$\bar{2}$	52	68	11
11	(?)	$+\frac{1}{3}\frac{5}{3}$	153	do	16	56	55	43	17	31	55	25
12	(?)	$-\frac{2}{5}3$	$\bar{2}.10.5$	do	$\bar{2}$	09	62	13	$\bar{2}$	32	68	11
13	(?)	$-\frac{5}{3}\frac{5}{6}$	$\overline{10}.5.6$	Poor	$\bar{3}\bar{6}$	54	42	16	$\bar{3}\bar{8}$	43	41	33



159



160

FIGS. 159–160.—159, LINARITE. PACIFIC MINE, CUSTER COUNTY. ORIENTED AND LETTERED ACCORDING TO GOLDSCHMIDT. DRAWN WITH *b*(010) IN FRONT. 160, LINARITE. CALEDONIA MINE, SHOSHONE COUNTY. ORIENTED AND LETTERED ACCORDING TO DANA.

The measurements show a sufficient agreement to establish the dentity of the mineral as well as to confirm the orientation. There are four of the terminal faces, however, which do not agree with any known forms for this mineral nor do they give any simple or rational indices. The approximate indices are given in the table. The angles may be compared as follows:

	°	′	°	′
(1) Form measured	$\varphi=16$	56	$\rho=55$	43
(153) calculated	$\varphi=17$	31	$\rho=55$	25
(2) Form measured	$\varphi=\bar{3}$	46	$\rho=67$	07
$(\bar{4}.15.5)$ calculated	$\varphi=\bar{2}$	52	$\rho=68$	11
$(\bar{1}41)$ calculated	$\varphi=\bar{3}$	52	$\rho=73$	15
$(\bar{1}31)$ calculated	$\varphi=\bar{5}$	09	$\rho=68$	10
(3) Form measured	$\varphi=2$	09	$\rho=62$	13
$(\bar{2}.10.5)$ calculated	$\varphi=2$	32	$\rho=58$	54
$(\bar{1}63)$ calculated	$\varphi=3$	40	$\rho=58$	58
(4) Form measured	$\varphi=\overline{36}$	54	$\rho=42$	16
$(\overline{10}.5.6)$	$\varphi=\overline{38}$	43	$\rho=41$	33
$(\bar{2}11)$	$\varphi=\overline{40}$	56	$\rho=47$	41

None of the forms can be considered as established by these data which merely serve to indicate the desirability of further study of material from the locality.

ELMORE COUNTY

Linarite occurs sparingly in a specimen from the Atlanta lode, Atlanta district, as films and thin crusts of minute deep blue crystals with anglesite lining cracks in coarse grained argentiferous galena containing grains of stephanite and pyrargyrite. The crystals are too small to be measured on the 2-circle goniometer nor could their form be deciphered by study under a binocular microscope.

FREMONT COUNTY

Linarite forms a bright blue crust of closely intergrown crystals in parallel position, on a mass of cerusite etc., in a specimen from the Wilbert mine in the Dome district as mentioned by Umpleby.[56] The crystals are not measurable.

OWYHEE COUNTY

Specimens from the Monkey mine, South Mountain district, contain stains and crusts of minute blue crystals of linarite with bindheimite in ashy gray anglesite which coats coarse galena. An old specimen from the Laxley mine, in this district, contains a considerable amount of linarite in indistinct crusts of intergrown blue crystals which are not suitable for measurement.

SHOSHONE COUNTY

Out of a lot of 10 specimens supposed to be azurite from the Caledonia mine, in the Coeur d' Alene district, 2 proved to be linarite.[57] The first of these shows a rosette about 1 cm in diameter of flat bladed blue crystals implanted on a joint surface in a mass made up of quartzite fragments cemented by cerusite and covellite. The linarite crystals are bright blue in color and more adamantine in luster than azurite. This showy rosette attracted attention to the specimen and the mineral was found, by chemical tests, to be linarite. This led to a more detailed examination of other specimens of supposed azurite from this mine and one other specimen was found to be linarite. This consists of massive cerusite colored dark by included unoxidized galena and encrusted by linarite, limonite, leadhillite, and a little caledonite. The linarite is implanted both upon the cerusite and the limonite in the form of minute blue flat prismatic crystals. Examined under the microscope these are seen to be elongated on the *b* axis and flattened, probably parallel to the basal pinacoid giving parallel extinction between crossed nicols which suggests orthorhombic symmetry. They are transparent bright blue by transmitted light and are nonpleochroic. While the crystals are not very satisfactory for measurement one was measured and found to have the habit shown in Figure 160. It gave the following angles:

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[56] J. B. Umpleby. U. S. Geol. Survey, Prof. Paper 97, p. 117, 1917.

[57] Earl V. Shannon. Linarite and leadhillite from Idaho. American Mineralogist, vol. 4, p. 93, 1919.

Measurements of linarite from the Caledonia mine, Wardner

Form		Symbol		Quality, description	Measured		Calculated	
No.	Letter	Gdt.	Miller		φ	ρ	φ	ρ
					° ′	° ′	° ′	° ′
1	*c*	0	001	Poor	92 00	14 58	90 00	15 11
2	*a*	∞0	100	Very good	90 00	90 00	90 00	90 00
3	*m*	∞	110	Good	30 50	90 00	30 50	90 00
4	*x*	+½0	102	Very good	90 41	27 18	90 00	27 26
5	*π*	+$\frac{4}{3}$0	403	Very poor	90 18	41 43	90 00	42 59
6	*s*	−10	$\bar{1}01$	Very good	87 07	12 42	90 00	12 37
7	*q*	−½(?)	$\bar{1}12$?	Very poor	3 19	12 42	3 16	22 34

It is probable that linarite was of fairly frequent occurrence in this mine, but it was confused with azurite while the oxidized ores were being worked.

Some small crusts of linarite have been seen on specimens from the Sierra Nevada mine in Deadwood Gulch.

Linarite occurs as a fine blue crust of indistinct columnar crystals associated with a little caledonite and leadhillite and some cerusite surrounding a lump of granular galena containing some chalcopyrite from the Lookout Mountain mine on Pine Creek.

A fine large crystal of linarite has been seen in a cavity in a mass of cerusite said to have come from the Hercules mine.

MIRABILITE (743)

GLAUBERS SALT

Hydrous sodium sulphate, $Na_2O.SO_3.10\ H_2O$. Monoclinic.

Mirabilite or glaubers salt occurs in Owyhee County and adjacent parts of Oregon as an efflorescence and mixed with niter, epsomite, and other salts.

OWYHEE COUNTY

Sodium sulphate, probably in part in the form of mirabilite, occurs mixed with other salts, including niter, sodium chloride, and magnesium sulphate, in soil at the foot of rhyolite cliffs along Jump Creek. At the Claytonia saline claims on Jump Creek west of the McCloud ranch a 10-inch bed of coarse salts consists principally of mixed glauberite and epsomite.[58]

GYPSUM (746)

Hydrous calcium sulphate, $CaO.SO_3.2\ H_2O$. Monoclinic.

Gypsum occurs both in fine granular massive form, known as rock gypsum or alabaster, and as clear colorless crystals or transparent grains, the latter known as selenite. The mineral may usually be distinguished from other substances which it resembles by its softness. It can be scratched with the finger nail. Rock gypsum is used to make plaster of Paris which is the basis of all hard plasters. The following localities have been recorded in Idaho:

ADAMS COUNTY

Gypsum in the form of clean perfectly transparent selenite intimately associated with massive bornite has been obtained from the South Peacock mine in the Seven Devils district.[59]

BANNOCK COUNTY

Gypsum occurs in the sulphur deposits 5 miles east of Soda Springs as small crystals associated with native sulphur.

BEAR LAKE COUNTY

Gypsum has been prospected 3 miles east of Montpelier on the south side of Montpelier Canyon. There is a prospect hole in the SW. ¼ sec. 32, T. 12 S., R. 45 E., where a small body of gypsum lies on and fills cracks in limestone of Pennsylvanian age.

The gypsum is fine grained, white, massive, and seemingly pure. It is not well exposed but the bed is at least 4 feet thick. The lateral extent was not determined. An analysis made in the laboratory of the United States Geological Survey of a cut 4 feet across the bed gave the following results:

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[58] G. R. Mansfield. Nitrate deposits in Idaho and Oregon. U. S. Geol. Survey, Bull. 620, pp. 24, 30–31, 1916.

[59] D. C. Livingston and F. B. Laney. Idaho Bur. Mines and Geol., Bull. 1, p. 63, 1920.

Analysis of gypsum (bed) near Montpelier

(W. C. Wheeler, analyst)

	Per cent
Silica (SiO_2)	4. 14
Alumina (Al_2O_3)	. 89
Ferric iron (Fe_2O_3)	. 10
Magnesia (MgO)	. 99
Lime (CaO)	31. 40
Carbon dioxide (CO_2)	2. 33
Sulphur trioxide (SO_3)	41. 13
Water (H_2O) loss at 200° C	18. 39
Total	99. 37

In the mountains, in the northeastern part of Bear Lake County, Mr. G. R. Mansfield found lenses and layers of gypsum in the nugget sandstone of Jurassic or Triassic age, but nowhere more than a few inches thick.[60]

CUSTER COUNTY

In the Alder Creek (Mackay) district gypsum occurs as veinlets in the oxidized ore and in the adjacent wall rock. Few of the veinlets exceed a centimeter in width and many are less than a millimeter across. The mineral also occurs as irregular grains sparsely scattered in the oxidized ore.[61]

ELMORE COUNTY

Samples showing abundant flakes and imperfect crystals of selenite scattered through clay have been sent to the National Museum by B. Z. Smith from Mountain Home.

OWYHEE COUNTY

Gypsum occurs in small amounts in soils with soluble sulphates, nitrates, etc., in niter claims on Jump Creek and elsewhere southeast of Homedale, Oreg. Gypsum, gypsiferous clay, and gypsiferous sand have been encountered in the Claytonia saline claim west of the McCloud ranch (pl. 30, lower).[62]

WASHINGTON COUNTY

Gypsum occurs with copper sulphate in oxidized silver ore of the Silver Bell mine in the Mineral district.[63]

A gypsum deposit in Washington County lies high in the bluffs of Snake River 10 miles northeast of Huntington, Oreg. Rock gypsum is exposed in short tunnels and pits in sections 7, 8, 17, and 18, T. 13 N., R. 7 W., and occurs in lenticular masses banded with grayish and greenish material, which range from 6 to 20 feet in thickness. Some of the gypsum is pure white, massive, and spotted with small lumps of impure gypsum and dark country rock; some is yellowish, owing to lumps of foreign material; and some is filled with laminae of a greenish mineral and small rolls of impure limy material.[64]

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[60] R. W. Stone and others. U. S. Geol. Survey Bull. 697, p. 99, 1920.

[61] J. B. Umpleby. U. S. Geol. Survey, Prof. Paper 97, p. 53, 1917.

[62] G. R. Mansfield. U. S. Geol. Survey, Bull. 620, p. 30, 1916.

[63] Waldemar Lindgren. Silver mines of Mineral, Idaho. U. S. Geol. Survey, 22d Ann. Rept., pt. 2, p. 755, 1901.

EPSOMITE (748)

EPSOM SALT

Magnesium sulphate, $MgO.SO_3.7H_2O$. Orthorhombic.

Epsomite, the native mineral having the same composition as the compound used in medicine under the name epsom salt, occurs somewhat abundantly with other saline minerals in the Homedale region in Oregon and in adjacent parts of Owyhee County.

OWYHEE COUNTY

On Jump Creek epsomite occurs in the Claytonia saline claim west of the McCloud ranch mixed with sodium sulphate as a bed of coarsely crystalline salts 10 inches thick.[65]

MELANTERITE (751)

COPPERAS

Hydrous ferrous sulphate, $FeO.SO_3.7H_2O$. Monoclinic.

Melanterite, having the same composition as the material called copperas or green vitriol, is a common product of the oxidation of iron sulphides but, owing to its easy solubility in water, it seldom accumulates except under unusually dry conditions. It is present in solution in many mine waters. The following occurrences have been noted:

ADAMS COUNTY

At the Red Ledge mine, in the Seven Devils district, water percolating through the rock containing disseminated sulphides is heavily charged with iron sulphate in solution and sulphates of iron, probably melanterite, accumulate in thick crusts in sheltered places along the Gaarden trail and elsewhere. No specimens of these sulphates have been available for examination.[66]

SHOSHONE COUNTY

Ferrous sulphate has been noted in a number of places in the Coeur d'Alene district, usually as a white efflorescence on decomposing sulphides. This white powdery material upon solution in water and recrystallization gives green melanterite crystals. It occurs as a pasty greenish-white material in cavities in decomposing pyrite from the Evolution prospect near Osburn. Certain fine grained massive pyrite from the Last Chance mine when placed in dry air becomes coated with a fine frost-like growth of delicate fibers of melanterite.

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[64] R. W. Stone and others. Gypsum deposits of the United States, U. S. Geol. Survey, Bull. 697, pp. 99–100, 1920.

[65] G. R. Mansfield. U. S. Geol. Survey, Bull. 620, p. 30, 1916.

[66] D. C. Livingston and F. B. Laney. Idaho Bur. Mines and Geol. Bull. 1, p. 54, 1920.

CHALCANTHITE (755)

BLUESTONE, BLUE VITRIOL

Hydrous copper sulphate, $CuO.SO_3.5H_2O$. Triclinic.

Chalcanthite or native blue vitriol commonly forms where copper sulphides are exposed to weathering, but being very soluble in water it seldom accumulates in any quantity except in very dry situations. In desert States this mineral sometimes occurs in large enough bodies to be of importance as an ore but in most Idaho districts the rainfall is so heavy that water-soluble minerals are rare. The following occurrences have been noted:

ADAMS COUNTY

Chalcanthite is reported by Livingston and Laney to occur in oxidized copper ores of the contact copper deposits of the Seven Devils district and also to be present in solution in the waters from the tunnels of the Red Ledge mine as shown by the fact that a bright piece of iron immersed in the mine waters becomes quickly coated with copper.[67] Bell [68] states that copper sulphate occurs interlayered with iron sulphate and native sulphur in masses several centimeters thick in little caves at the foot of the cliff at the Red Ledge mine.

BOISE COUNTY

Chalcanthite occurs as a pale blue efflorescent crust on a specimen of pyritic ore from the dump of the lower tunnel of the Mohawk mine, Summit Flat district.

CUSTER COUNTY

Chalcanthite occurs in the Alder Creek (Mackay) district in the ores of the Copper Bullion mine as thin coatings composed of distinctly fibrous crystals.[69]

A specimen of partly oxidized chalcopyrite-limonite ore from the surface workings of the Lost Packer mine is partly incrusted with a pale blue efflorescence. The blue mineral which is a water soluble copper sulphate is very pale blue under the microscope and is biaxial negative with 2V large, dispersion $r<v$ pronounced, β index of refrac-

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[67] Idaho Bur. Mines and Geol. Bull. 1, pp. 55 and 67, 1920.

[68] Robert N. Bell. Ann. Rep., State Mine Inspector for 1913, p. 167.

[69] J. B. Umpleby. U. S. Geol. Survey, Prof. Paper 97, p. 50, 1917.

tion below 1.53 and γ index above 1.53. These properties identify the mineral as chalcanthite.

SHOSHONE COUNTY

Chalcanthite deposits from mine waters as small blue stalactites in tunnels of the Evolution prospect near Osburn and the Wisconsin prospect on the north side of the river west of Moon Gulch. In the upper tunnel of the Lombardy prospect in Italian Gulch north of Kellogg thin crusts of chalcanthite coat the walls of drifts and, shelling off, accumulate in the soil of the floor.

WASHINGTON COUNTY

A body 40 feet square of high grade oxidized ore rich in copper sulphate and gypsum occurred in the Silver Bell mine, Mineral district.[70]

GOSLARITE (749)

WHITE VITRIOL, ZINC VITRIOL

Hydrous zinc sulphate, $ZnO.SO_3.7H_2O$. Orthorhombic.

Zinc sulphate has never been definitely identified in the State, although it probably occurs, but like other soluble sulphates it is removed in solution. It may occur in the Coeur d'Alene district.

SHOSHONE COUNTY

In many places in the Coeur d' Alene district dry drifts have their rock coated with sparkling crusts of some soluble mineral or minerals, a part of which may be goslarite. Such sparkling crystals have been seen by the writer in the Greenhill-Cleveland mine and on the walls of the pumping stations of the Bunker Hill mine. Stout fibers occurring abundantly mixed with limonite from one of the upper tunnels of the Stemwinder mine at Wardner collected in 1912 by John Goettge and Harry McDougall, of Wardner, were soluble in water with the astringent taste of goslarite but were not tested chemically.

KALINITE (764)

COMMON ALUM, POTASH ALUM

Hydrous potassium aluminium sulphate, $K_2O.Al_2O_3.4SO_3.24H_2O$. Isometric.

Although kalinite has never been definitely reported as such from Idaho it is assumed that this mineral is meant by a reference to the occurrence of alum.

BANNOCK COUNTY

Alum, presumably kalinite, is reported to occur in the sulphur ore of the sulphur deposits near Soda Springs.[71] The mineral has doubtless formed by the action of the acid water of the sulphur springs on the volcanic tuff in which the deposits occur.

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[70] Waldemar Lindgren. U. S. Geol. Survey, 22d Ann. Rept., pt. 2, p. 755, 1901.

[71] R. W. Richards and J. H. Bridges. U. S. Geol. Survey, Bull. 470, p. 503, 1911.

MENDOZITE (776)

Hydrous sulphate of sodium and aluminium, $Na_2O.Al_2O_3.4SO_4.24H_2O$.	Fibrous.

Although its existence here has not been established, mendozite may occur in Owyhee County.

OWYHEE COUNTY

Just below the falls of Jump Creek there is a ferruginous zone about 1 meter wide along which and to the north of which the rock is much fractured. Just above this a little nitrate has been found in a little recess which has been deepened by picking. The nitrate has all been removed but crevices contain a white coarsely fibrous prismatic salt in veinlets up to 2 cm. wide (pl. 30, upper) with a strong astringent alum-like taste. A qualitative test shows very little potash but abundant sodium, magnesium, and aluminium. The substance is essentially a combination of the sulphates of these three elements.[72] These sulphates may be present as alunogen, mirabilite, and epsomite, but the characters of the material and the astringent taste would seem to indicate that they are present as alums, the magnesium as pickeringite, and the soda as mendozite. This could be established by optical examination but no samples have been available for study.

PICKERINGITE (768)

MAGNESIA ALUM

Hydrous magnesium aluminium sulphate, $MgO.Al_2O_3.4SO_3.22H_2O$.	Monoclinic.

Pickeringite probably occurs with other salts in Owyhee County, as it has been definitely identified in the same region on the Oregon side of the State line.

OWYHEE COUNTY

As has been mentioned above under mendozite there occurs in crevices in rhyolite in a nitrate prospect just below the falls of Jump Creek a white coarsely fibrous or prismatic salt in veinlets up to 1 cm. wide. This has been found to consist of sulphates of aluminium, magnesium, and sodium and, from the fact that the material has a strongly astringent taste like the alums it is presumed that they are combined in the double sulphates with alumina, in which case the magnesia is in the form of pickeringite.[73]

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[72] G. R. Mansfield. U. S. Geol. Survey, Bull. 620, pp. 24–25, 1916.

[73] G. R. Mansfield. U. S. Geol. Survey, Bull. 620, p. 24–25, 1916.

JAROSITE (801)

Basic sulphate of potash and ferric iron, Rhombohedral.
$K_2O.3Fe_2O_3.4SO_3.6H_2O$.

Jarosite is a sulphate which has been found to occur abundantly in certain Utah and Nevada ore bodies in the oxidized ore, associated with other members of the jarosite group in which the potash is replaced by soda, lead, or silver. The mineral was long overlooked because it closely resembles limonite and it may have been generally overlooked in Idaho also. It has been identified from two localities in this State.

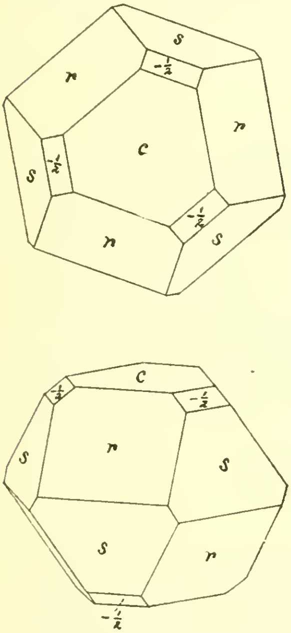

FIG. 161.—JAROSITE. MACKAY DISTRICT, CUSTER COUNTY

CUSTER COUNTY

Unusually well-crystallized jarosite occurs in a specimen labeled "Quartzite from just above limestone, Cherry Creek, Mackay district," and the accompanying notes read "went up Cherry Creek until I came to iron-stained quartzite outcrop, then went to top of ridge and found limestone-quartzite contact." It is not clear whether the specimen came from the creek or the top of the ridge, but presumably it is from the creek and can be found again by the same procedure. To judge from this single chance specimen, a little work would result in securing exceptionally fine specimens of the mineral. The rock is cherty and probably is from a brecciated and silicified zone in limestone.

The jarosite forms thick tabular crystals up to 2 mm. in diameter, of a golden brown color. They are simple in development as illustrated in Figure 161. The form −½ ($\bar{1}\bar{1}22$) is apparently new for the species. The crystals are not well adapted for measurement and give poor reflections. The measurements obtained are as follows:

Measurements of jarosite from Custer County

Form		Symbol		Quality, description	Measured		Calculated	
No.	Letter	Gdt.	Miller		φ	ρ	φ	ρ
					° ′	° ′	° ′	° ′
1	*c*	0	0001	Poor, curved	— —	0 00	— —	0 00
2	*r*	1	$11\bar{2}1$	do	30 00	55 45	30 00	55 17
3	*s*	2	$\bar{2}\bar{2}41$	do	30 00	70 22	30 00	70 53
4	New	−½	$\bar{1}\bar{1}22$	do	30 00	34 40	30 00	35 49

The mineral is apparently ordinary potash jarosite and contains no soda or lead. Under the microscope the powder is pleochroic in brown and nearly colorless. It is biaxial negative with small axial angle and strong birefringence. The crystals are zoned and the refractive index varies in different zones. The approximate indices are $\alpha = 1.70$, $\gamma = 1.80$.

The usual mode of occurrence of jarosite is as microscopic scales in aggregates of earthy appearance resembling limonite. With the exception of a single lot of material collected by W. F. Foshag, at Pioche, Nev., no specimens showing coarse crystals like those of the Idaho specimen have ever been found before.

LEMHI COUNTY

A specimen from the Parker Mountain mine, Parker Mountain district, contains small waxy brown areas which are apparently pseudomorphs after pyrite crystals, embedded in white clay. The brown material is transparent under the microscope and is composed of fine grains which are uniaxial or nearly so with moderately high birefringence. The lowest index of refraction α is about 1,702. The mineral dissolves in hot concentrated hydrochloric acid and the solution reacts for ferric iron and sulphuric acid. The mineral is doubtless jarosite.

PLUMBOJAROSITE (801a)

Basic sulphate of lead and ferric iron, $PbO.3Fe_2O_3.4SO_3.6H_2O$. Rhombohedral.

The lead member of the jarosite group closely resembles ordinary or potash jarosite and like it in its usual massive form closely resembles limonite. This lead mineral has been found to be so widespread in occurence in similar ores in Utah and Nevada that it is odd that it has not been found from a number of Idaho mines. The only recorded locality is in Fremont county.

FREMONT COUNTY

Plumbojarosite has been listed by Umpleby[74] as occurring in oxidized lead ores of the Kaufman and Weaver mine in the Skull Canyon district.

THE WOLFRAMITE GROUP

The wolframite group includes those tungstates of iron and manganese included under the old name wolfram or wolframite. There are two recognized end members of this group, ferberite, or iron tungstate free from manganese, and hubnerite, which is manganese tungstate free from iron or nearly so. The group name, wolframite, is therefore without strict mineralogic significance and is used loosely to indicate isomorphous mixtures of the two end members which contain both iron and manganese. The Idaho materials described below as wolframite are those whose composition has not been determined and they may include some ferberites or hubnerites.

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[74] J. B. Umpleby. U. S. Geol. Survey, Prof. Paper 97, p. 91, 1917.

WOLFRAMITE (812)

Iron-manganese tungstate $(Fe,Mn)O.WO_3$. Monoclinic.

The occurrences of minerals of the wolframite group in Idaho which are not mentioned under hubnerite or ferberite are as follows:

BOISE COUNTY

Wolframite occurs as reddish to brownish black cleavable masses disseminated in quartz from the Horse Fly prospect and as very black indistinct friable material in vuggy quartz coated with a thin layer of chalcedonic silica in specimens from the Merry Blue mine, both in the Deadwood Basin.

BUTTE COUNTY

Wolframite occurs in a quartz vein in the Independence claims near the summit of Granite Mountain 20 miles from Arco on the Hailey-Arco trail. The vein, which is at the contact between diorite and a siliceous rock, averages 6 feet wide and is made up of crystalline drusy quartz heavily stained with iron and manganese. The wolframite occurs as occasional scattered black crystals and bladed masses.[75]

LEMHI COUNTY

Large plates of wolframite occur in massive quartz in specimens sent to the United States Geological Survey by Fred Gerdes of Leadore, Idaho.

HUBNERITE (813a)

Manganese tungstate, $MnO.WO_3$. Monoclinic.

Hubnerite has been mined in two places in Idaho, one of which has made a notable production of tungsten ore.

BONNER COUNTY

Hubnerite occurs in veins near Talache on the west shore of Lake Pend Orielle. These deposits have been examined by Mr. Edward Sampson of the United States Geological Survey and will be described in a report by him which is now in preparation.

LEMHI COUNTY

Hubnerite occurs in sufficient abundance in the Blue Wing district in Lemhi County to have been mined to some extent as a tungsten ore.[76] The hubnerite has been mined principally in the Ima mine from a filled fissure in quartzite which is traceable for over 1,000 feet. The vein filling is drusy white quartz and many small unfilled spaces occur between the quartz grains and crystals. The minerals in the quartz are hubnerite, tetrahedrite, galena, sphalerite, pyrite, and molybdenite, apparently all contemporaneous. Other veins occur but are smaller and less persistent than the main vein. The tetrahedrite is argentiferous and the mine was formerly worked for silver.[77] The hubnerite occurs in large brown blades embedded in the quarts. These have a bronzy luster and distinct cleavage. Some of them are 6 or 7 cm. in length. The following analyses of hubnerite from this locality have been made.

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[75] D. C. Livingston. Univ. of Idaho School of Mines, Bull. 2, p. 28, 1919.

[76] J. B. Umpleby. U. S. Geol. Survey, Bull. 528, pp. 73-74, 1913.

Analyses of hubnerite from Lemhi County

	W. T. Schaller [1]	J. E. Talmadge [2]
Tungsten trioxide (WO_3)	76.60	75.94
Manganese oxide (MnO)	21.40	21.57
Ferrous oxide (FeO)	2.00	2.38
Total	100.00	99.89

[1] U. S. Geol. Survey Bull. 591, p. 365, 1915.
[2] F. L. Hess. U. S. Geol. Survey Bull. 583, p. 24, 1914.

A third analysis by the writer (E. V. S.) gave practically identical results.

FERBERITE (813 b)

Iron tungstate, $FeO.WO_3$. Monoclinic.

The only locality for the iron end member of the wolframite series thus far known in Idaho is in Camas County.

CAMAS COUNTY

Ferberite occurs in 3 narrow parallel quartz veins 1 to 10 cm. wide and about 50 cm. apart in trachyte or syenite porphyry on Corral Creek near Soldier Mountain in Camas County. The rock is light colored with prominent white phenocrysts which are completely kaolinized in the vicinity of the mine.[78] The ferberite fills fractures in the brecciated rock and occurs as drusy crystals lining open spaces producing specimens which greatly resemble those from the Boulder County, Colo., field. The larger crystals are striated and rounded while the smaller are combinations of the base *c*(001), the dome *n*(401), and the pinacoid *b*(010), as illustrated in Figure 163. They are elongated on the *a* axis. Some of them have notched ends and appear to be twinned on *c*(001) as illustrated in Figure 162. The crystals are coated with limonite but are dead black in color.

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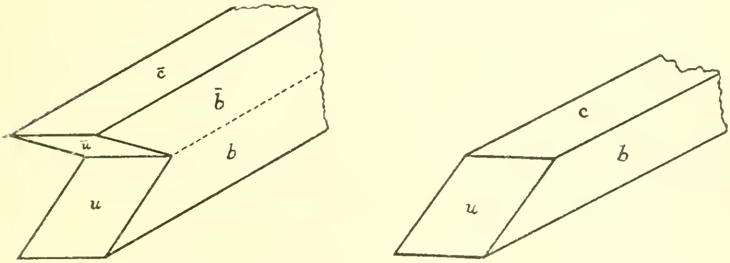
[77] D. C. Livingston. Idaho School of Mines, Bull. 2, pp. 22–25, 1919.
[78] D. C. Livingston. Univ. of Idaho School of Mines Bulletin, vol. 14, No. 2, pp. 25–26, 1919.

An analysis, in which the value for tungsten is low, was made and gave the following results:

Analysis of ferberite from Camas County

(E. V. Shannon, analyst)

	Per cent
Silica (SiO_2)	1. 82
Iron oxide (FeO)	22. 32
Manganese oxide (MnO)	1. 69
Tungsten trioxide (WO_3)	71. 88
Molybdenum trioxide (MoO_3)	. 15
Line (CaO)	Trace.
Magnesia (MgO)	Trace.
Total	97. 86



FIGS. 162–163.—FERBERITE. SOLDIER, CAMAS COUNTY

SCHEELITE (814)

Calcium tungstate, $CaO.WO_3$. Tetragonal.

Scheelite is known from a number of localities in the State and some production of tungsten ore has been made from the Coeur d'Alene district in Shoshone County in which the tungsten was in this form.

BLAINE COUNTY

Small quantities of scheelite are reported from the North Fork mining district near Ketchum.[79]

BOUNDARY COUNTY

Scheelite occurs in drusy crystalline quartz filling a fissure in diorite near Copeland in Boundary County. The quartz contains limonite-filled cavities and the scheelite is associated with this limonite, some of it in coarse crystals, but most of it so finely divided in the vein as to be shown only by the panning or analysis of apparently barren material.[80]

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[79] U. S. Geol. Survey, Useful Minerals of the United States, Bull. 624, p. 120, 1917.

[80] D. C. Livingston. Univ. of Idaho Sch. of Mines, Bull. 2, pp. 12–14, 1919.

IDAHO COUNTY

The first notice of the occurrence of scheelite in Idaho County is by Benjamin Silliman,[81] who writes that a specimen was sent him by a correspondent from the Charity Vein in the Warren district. The material was mistaken for grossularite garnet on account of its resemblance in color by the miners, but its high specific gravity attracted attention. Gold occurs associated with a small amount of pyrite scattered through the scheelite and there was a little chalcopyrite and arsenopyrite in minute grains in the specimen. The scheelite was massive with few crystalline faces and had a yellow-brown color resembling chondrodite. The miners had struck a pocket of the scheelite-bearing ore and in a few evenings pounded out a $1,000 gold value from a few candle boxes of the ore in a hand mortar. This ore was thus very rich, although it is said that the ore of the mine usually paid only about $20 a ton. It has recently been stated that scheelite occurs in several gold-bearing quartz veins in granite of the Unity Gold Mines Co., formerly the Little Giant, Charity, and other mines near Warren.[82]

Buff scheelite occurs in grains and small masses disseminated in quartz of specimens from the claims of the New York Mining Co. near Newsome in the Ten Mile district.

LEMHI COUNTY

A little scheelite occurs in hubnerite-bearing veins in the Ima mine, Blue Wing district, as a secondary product, in thin pale yellow to white crusts lining open spaces in the coarse quartz gangue.[83] A little scheelite occurs with the molybdenite (q. v.) of the Mulkey prospect.[84]

SHOSHONE COUNTY

The earliest published reference to the occurrence of scheelite in Shoshone County appears to be that by Blake,[85] who writes that "tungstate of lime occurs massive in an auriferous quartz vein near the town of Murray, Idaho Territory, on the western slope of the Coeur d'Alene Mountains." In 1908 Auerbach[86] published an excellent paper on the occurrence of the mineral in this district. He says that the mineral has been found within a circle of about 3 miles radius taking Murray as the center. The principal localities were the Golden Chest and Golden Winnie properties, but the mineral had been found in other places in less quantities. In the days of the gold rush a German prospector uncovered a 2-foot vein of scheelite in Pony Gulch. Because of the weight of the mineral he mistook it for an ore of lead, but when an assay showed none of that metal he abandoned the vein. During placer operations on Trail and Pony Gulches scheelite was frequently found on the bed rock and in Eagle and Tributary Gulches it is washed into sluice boxes. Dunlap and Smith, while placer mining in Eagle Creek, uncovered a small vein near the Columbus group.

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[81] On an association of gold with scheelite in Idaho. Amer. Journ. Sci., vol. 13, p. 451–452, 1877.

[82] D. C. Livingston. Univ. of Idaho Sch. of Mines, Bull. 2, pp. 26–27, 1919.

[83] J. B. Umpleby. U. S. Geol. Survey, Bull. 528, p. 79, 1913.

[84] D. C. Livingston. Univ. of Idaho Sch. of Mines, Bull. 2, p. 41, 1919.

[85] W. P. Blake. Scheelite from Idaho. Amer. Journ. Sci., vol. 37, p. 414, 1889.

[86] Herbert S. Auerbach. Tungsten ore deposits of the Coeur d'Alene. Engin. and Min. Journ., vol. 86, p. 1146–1148, 1908.

In the Golden Chest mine, of which Auerbach was manager, he writes that the scheelite occurred in the Klondike shoot on the Katie and Dora vein in white quartz which contains abundant pyrite and less chalcopyrite and galena. The scheelite was found in a shoot about 75 feet long and had been followed to a vertical depth of 350 feet. In one place there were 5 feet of excellent grade scheelite ore with a maximum thickness of 3 feet of pure scheelite. In another portion of the vein the concentrating ore carrying disseminated scheelite was 15 feet wide. While the scheelite ore formed a well defined shoot the bodies themselves were irregular pinching down to streaks, branching out into numerous veinlets and again uniting to form large solid bodies. About 50 tons of scheelite had been removed from the mine previous to 1908. Auerbach illustrates a number of excellent specimens of the scheelite. Some masses weighed 100 pounds and consisted of pure scheelite.

During the war demand for tungsten from 1914 to 1918 considerable interest was aroused and the scheelite occurrences near Murray were actively prospected and some production of tungsten ore made. The Golden Chest mine was the principal producer. The Friday group, formerly the Golden Winnie or Arrastre Smith property, mined some scheelite which occurred mixed with pyrite in a flat, greatly shattered and somewhat oxidized quartz vein. This property is located at the south side of Prichard Creek about 2 miles below Murray.

The Mother lode on the south side of Ophir Gulch about 2,000 feet from its mouth on Prichard Creek almost opposite the Golden Chest mine has opened gold veins of the same system as those of the Golden Chest mine, but these contain no scheelite. Scheelite occurs on the property in bunches associated with narrow seams of quartz distributed through a dike of diabase or similar basic igneous rock.

In the Kennan property on Pony Gulch, a tributary to Beaver Creek, scheelite occurs rather abundantly in quartz seams in a shattered zone in quartzitic slate. Individual masses of the scheelite reach 10 cm. or more in diameter.[87]

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[87] D. C. Livingston. Univ. of Idaho. Sch. of Mines, Bull. 2, pp. 15–21, 1919.

The scheelite from the Coeur d'Alene district is for the most part massive and it all has a translucent buff color. Distinct crystals have been seen by the writer only as minute druses lining cracks in the massive mineral. The scheelite is associated with auriferous pyrite in quartz with usually small amounts of other sulphides. A typical specimen showing these associations is illustrated in Plate 19 (lower).

POWELLITE (816)

Calcium molybdate, Tetragonal.
$CaO.MoO_3$.

The calcium molybdate, powellite, corresponding to the calcium tungstate, scheelite, was first described as a new mineral from Idaho and named in honor of Maj. J. W. Powell, director of the United States Geological Survey, by W. H. Melville, whose description is abstracted below.[88]

ADAMS COUNTY

A piece of ore, friable from weathering, picked up on the dump of one of the tunnels of the Peacock claim, Seven Devils district, in 1890, consisted of light-brown garnet, bornite, and a mineral suggesting scheelite in appearance, which upon examination was found to be the new species, calcium molybdate. The mineral resembles scheelite and shows a poor cleavage. The color is yellow with a decided green tinge. The crystals are semitransparent and are brittle and the hardness is less than that of scheelite, or about 3.5. The specific gravity is 4.526 the mean of two determinations. The blowpipe characteristics are those commonly given under molybdates and tungstates, the molybdenum obscuring the tungsten associated with it. It fuses at 5 to a gray mass and is decomposed by nitric and hydrochloric acids. Associated with the powellite is a small amount of olive-green molybdic ocher apparently resulting from its decomposition. Crystallographically the powellite is tetragonal and isomorphous with scheelite. The best crystals are about 1 mm. long and others reach a maximum length of nearly 3 mm. They are closely allied to scheelite in form and habit, the appearance and development being essentially like Figure 164. The angles are so

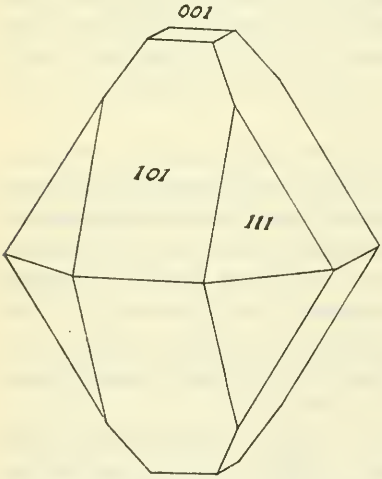

FIG. 164.—POWELLITE, SEVEN DEVILS DISTRICT, ADAMS COUNTY. AFTER MELVILLE

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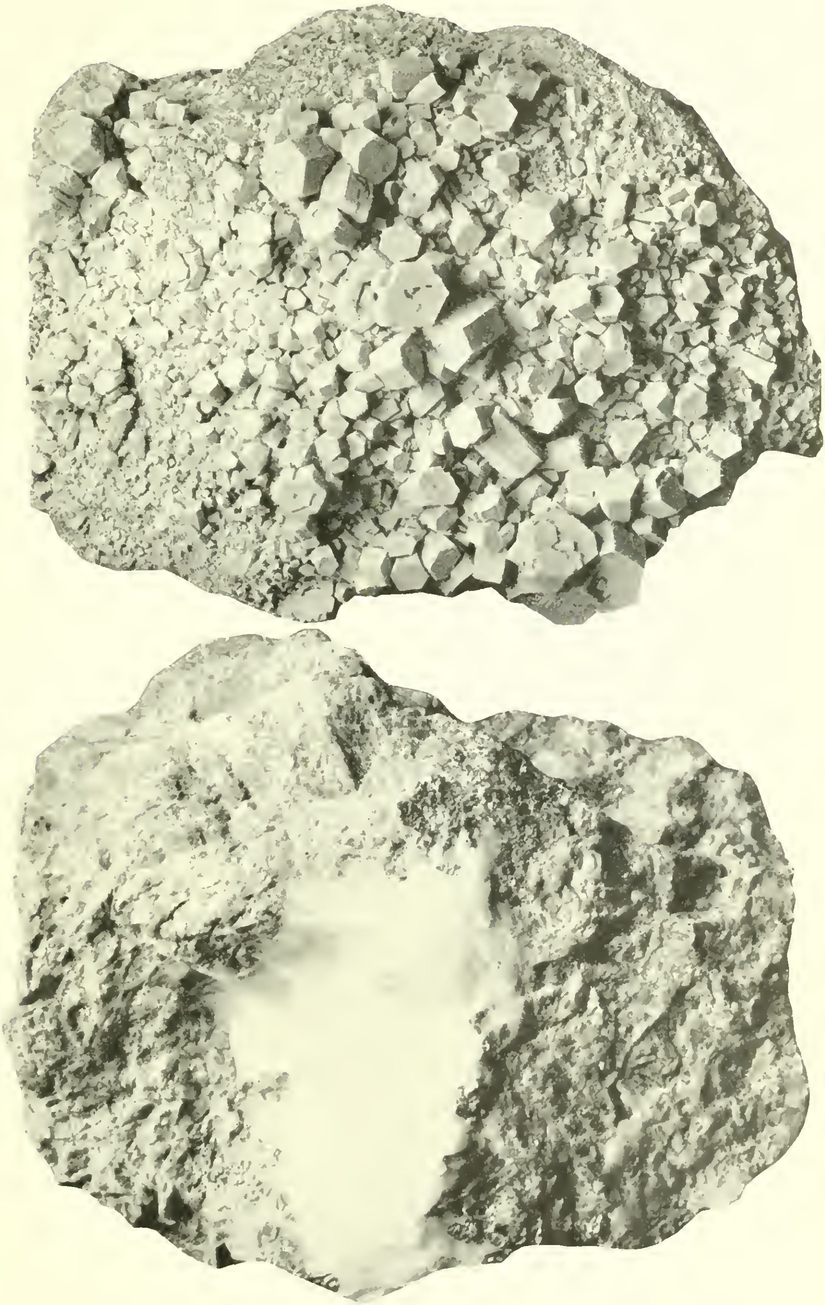
[88] W. H. Melville. Amer. Journ. Sci., vol. 41, p. 138, 1891.



PYROMORPHITE AND SCHEELITE

FOR DESCRIPTION OF PLATE SEE PAGES 421 AND 472

close to those of scheelite as to make the two minerals almost inseparable, crystallographically. The forms observed are $c(001)$, $p(111)$, $e(101)$. Small rudimentary planes appear on some crystals at the lower portion of the combination edge $(111) \wedge (101)$ suggesting hemihedrism as in scheelite, or these edges are rounded as if fused. The axial ratios derived for the mineral are compared with those of scheelite as follows:

Powellite	$c=1.5445$
Scheelite	$c=1.5368$

The angles measured on the one circle goniometer are compared with the calculated angles for powellite and scheelite below.

Measurements of powellite from Seven Devils

	Powellite, observed	Powellite, calculated	Scheelite, calculated
	° ′	° ′	° ′
(111) : (111)	49 12	Fundamental.	49 27
(001) : (111)	65 24	65 24	65 16
(111) : (111)	79 57	80 01	79 56
(101) : (101)	65 55	65 51	66 06
(101) : (111)	40 02	40 01	38 58

The powellite was analyzed with the following results:

Analysis of powellite from Idaho

(W. H. Melville, analyst)

	Per cent
Molybdenum trioxide (MoO_3)	58. 58
Tungsten trioxide (WO_3)	10. 28
Silica (SiO_2)	3. 25
Lime (CaO)	25. 55
Magnesia (MgO)	. 16
Ferric iron oxide (Fe_2O_3)	1. 65
Alumina (Al_2O_3)	Trace.
Copper oxide (CuO)	Trace.
Total	99. 47

Larsen[89] has determined the powellite from the original specimen to be uniaxial positive with the refractive indices:

$$\omega=1.967 \pm 0.005 \qquad \epsilon=1.978 \pm 0.005.$$

Although powellite has since been found in a number of localities, no second specimen has ever been obtained from the original locality This is probably because no one familiar with the inconspicuous appearance of the mineral has made a search.

---

[89] Esper S. Larsen. U. S. Geol. Survey, Bull. 679, p. 122, 1921.

CUSTER COUNTY

Powellite occurs as an alteration product of molybdenite in several specimens labeled as from the Bay Horse district in Custer County. The powellite forms dirty white pearly plates up to 1 cm. broad interleaved with molybdenite. A little molybdite is associated with the powellite.

STOLZITE (817)

Lead tungstate, $PbO.WO_3$ Tetragonal.

Only one report of the existence of stolzite in Idaho has been received.

SHOSHONE COUNTY

Stolzite is reported to have been found with other oxidized lead minerals in the Hypotheek mine near Kingston in 1916.[90] No specimens of the mineral nor any detailed notes on its occurrence have been available.

WULFENITE (818)

Lead molybdate, $PbO.MoO_3$. Tetragonal

Although nowhere abundant or in exceptionally large and fine crystals, the orange yellow lead molybdate has been examined or reported from the following localities:

BEAR LAKE COUNTY

Wulfenite occurs in the Blackstone claim, St. Charles district, in the Bear River Range, on the north side of St. Charles Creek, 3½ miles west of the town of St. Charles. The mineral is in wax-yellow tabular crystals associated with cerusite.[91]

BLAINE COUNTY

A number of specimens collected by D. F. Hewett, of the United States Geological Survey, from the Golden Bell mine near the head of the ravine which contains the Minnie Moore mine, near Bellevue, contain small orange-yellow crystals of wulfenite abundantly distributed in siliceous skeletal masses. The crystals vary considerably in development. Many of them are square tablets, showing only a single prism and basal pinacoid (fig. 165). Many are tabular combinations of the base *c*(001) and the pyramid *p*(111) with the corners truncated by *e*(011), while in others the dominating form bounding the tables is *e*(011) and *p*(111) forms only small corner faces. In a few of the latter *m*(110) is present as narrow faces. Some of the crystals appear hemimorphic with the pyramidal faces above and only the basal pinacoid below. The angles measured are as follows:

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[90] Ernest Leroy Adkins. Personal letter, 1917.

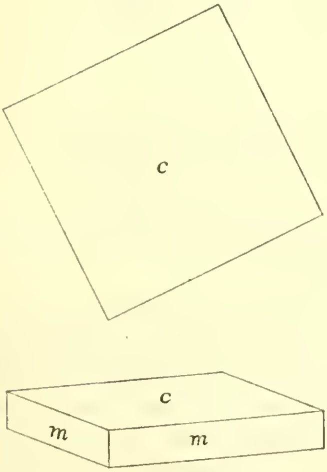
[91] R. W. Richards. U. S. Geol. Survey, Bull. 470, p. 182, 1911.

Measurements of wulfenite from Blaine County

Form		Symbol		Quality, description	Measured		Calculated	
No.	Letter	Gdt.	Miller		φ	ρ	φ	ρ
					° ′	° ′	° ′	° ′
1	*c*	0	001	Poor	-- --	0 00	-- --	0 00
2	*m*	∞	110	Very poor	45 08	90 00	45 00	90 00
3	*p*	1	111	Good	45 10	65 25	45 00	65 51
4	*e*	01	011	Excellent	0 00	57 23	0 00	57 37

FREMONT COUNTY

In the Old Scott mine of the Birch Creek Mining Co., in the Birch Creek district, the principal minerals of the ore are cerusite, anglesite, and galena. Above the 100-foot level carbonates predominate and here wulfenite, though comparatively rare, is conspicuous because of its orange color.[92] A number of specimens have been examined from this mine and some crystals have been measured. These are all tabular plates but they vary somewhat in habit. Small orange crystals in manganese-stained sand carbonate ore are tabular and bounded by *b*(113) and narrow faces of *p*(111) with the corners bearing narrow line faces of τ (013) (fig. 166). Specimens from the 150-foot level north of the shaft contain small orange-wulfenite crystals with cerusite on calcite and steel galena. These crystals, which are thick tabular, are bounded by well-developed faces of *o*(012)



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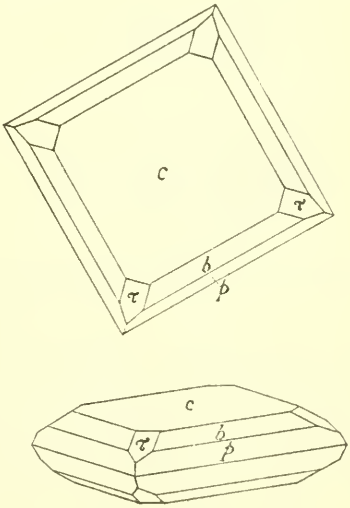

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Figs. 165–166.—165, Wulfenite. Golden Bell mine, Blaine County. 166, Wulfenite. Old Scott mine, Fremont County and *p*(111) with narrow faces of *e*(011) and minute faces of the prisms *β*(230) and *q*(120).

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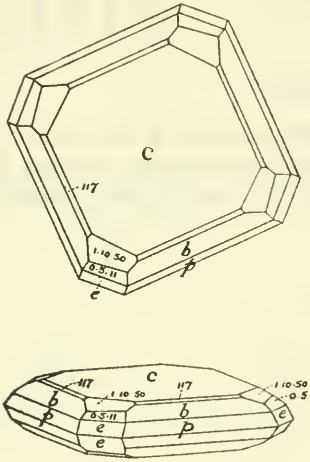
[92] J. B. Umpleby. U. S. Geol. Survey, Prof. Paper 97, p. 119, 1917.

Another specimen from the 150 foot level of the Old Scott mine contains larger pale yellow wulfenite crystals in pale yellow ocher associated with wad. The best of these was measured and found to show, in addition to *c*(001), *p*(111), and *b*(113), faces indicating new or vicinal forms giving the indices (117), (1.10.50), and (0.5.11) (fig. 164). Another crystal is bounded by *b*(113) and narrow faces of *p*(111) with the corners beveled by a form giving the indices (038) (fig. 167). Still another crystal showing *c*(001), *p*(111), and *e*(011), has small faces of *m*(110), and another new form (121) (fig. 169). This makes a total of 5 forms on crystals from this locality which could not be correlated with established forms for the species. These may be stated, with their angles, as follows:



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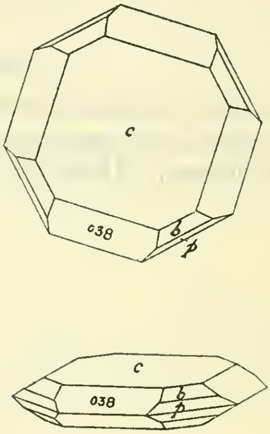

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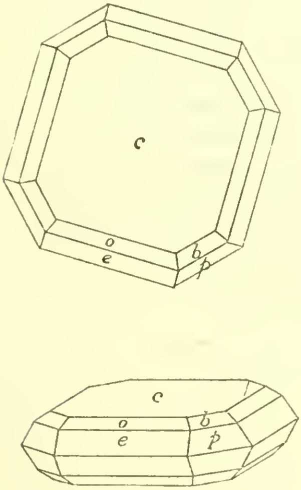
FIGS. 167–168.—167, WULFENITE. OLD SCOTT MINE, FREMONT COUNTY. 168, WULFENITE. LENA DELTA MINE, LEMHI COUNTY

		°	′	°	
(1)	Form measured	φ=26	14	ρ=74	15
	(121) calculated	φ=26	34	ρ=74	10
(2)	Form measured	φ= 0	41	ρ=30	32
	(038) calculated	φ= 0	00	ρ=30	36
(3)	Form measured	φ=45	00	ρ=17	00
	(117) calculated	φ=45	00	ρ=17	40
(4)	Form measured	φ= 5	27	ρ=17	30
	(1.10.50) calculated	φ= 5	42	ρ=17	37
(5)	Form measured	φ= 0	00	ρ=35	42
	(0.5.11) calculated	φ= 0	00	ρ=35	39

All of the forms noted on crystals from this locality with their angles are given in the following table:

Measurements of wulfenite crystals from Old Scott Mine

Form		Symbol		Quality, description	Measured				Calculated			
No.	Letter	Gdt.	Miller		φ		ρ		φ		ρ	
					°	′	°	′	°	′	°	′
1	*c*	0	001	Medium	--	--	0	00	--	--	0	00
2	*m*	∞	110	Poor	45	03	90	00	45	00	90	00
3	*q*	∞2	120	Fair	25	53	90	00	26	34	90	00
4	*β*	∞$\frac{3}{2}$	230	do	34	38	90	00	33	41	90	00
5	*e*	01	011	do	0	00	57	23	0	00	57	37
6	*o*	0½	012	Good	0	00	37	32	0	00	38	16
7	*τ*	0⅓	013	Poor	0	02	25	37	0	00	27	44
8	New(?)	0⅜	038	Medium	0	41	30	32	0	00	30	36
9	New	0$\frac{5}{11}$	0. 5. 11	Fair	0	00	35	42	0	00	35	39
10	*p*	1	111	Medium	44	58	65	46	45	00	65	51
11	*b*	⅓	113	Good	45	10	36	25	45	00	36	38
12	New(?)	1/7	117	Poor	45	00	17	00	45	00	17	40
13	New	12	121	Fair	26	14	74	15	26	34	74	10
14	New	1⅕	1. 10. 50	Good	5	27	17	30	5	42	17	37



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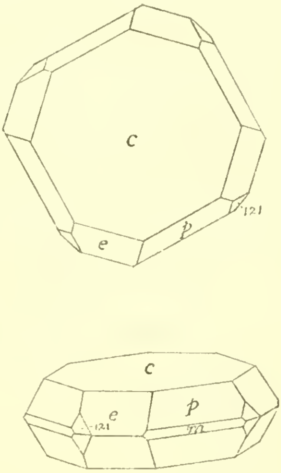

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FIGS. 169-170.—WULFENITE. OLD SCOTT MINE, FREMONT COUNTY

The material available is scanty and only a few crystals could be obtained which were suitable for measurement.

Wulfenite also occurs in the Weimer copper mine in the Skull Canyon district as small orange crystals with anglesite and cerusite surrounding galena in barite and as pale yellow crystals on manganese oxide.

IDAHO COUNTY

Minute orange yellow films of wulfenite occur on cracks in a white rock from the Free Gold mine of W. C. Cooper and S. T. Muldrow in the Dixie district.

LEMHI COUNTY

An old specimen (Cat. No. 56532, U. S. N. M.) labeled as from the Lena Delta mine, Lemhi County, contains a few pale yellow tabular wulfenite crystals in ocherous limonite. The crystals are bounded by *e*(011), *o*(012), *p*(111), and *b*(113) (fig. 168).

MINERAL COAL

Despite its practical value and importance coal is of little value or interest to the mineralogist and can scarcely be properly regarded as a mineral. The following abstracts merely include references to the most noteworthy occurrences of coal in Idaho.

BOISE COUNTY

Subbituminous or lignite coal occurs in Boise County at Horseshoe Bend and Jerusalem Valley on Payette River, 20 miles north of Boise and 40 miles southeast of Weiser. The field occupied by the coal-bearing formation is about 15 miles long in a northeast-southwest direction with an area of about 23 square miles. The beds of coal, which are mostly less than 14 inches thick, occur interstratified with unconsolidated sands and clays belonging to the Payette formation which is of Eocene age. The coal has a pitch-black color, vitreous luster, black streak, bedded structure, a tendency to prismatic cleavage, an irregular to subconchoidal fracture and a dense texture. A typical analysis is as follows:[93]

Analysis of coal from Henry mine, Horseshoe Bend

	Per cent
Moisture	5. 00
Volatile matter	40. 40
Fixed carbon	38. 10
Ash	16. 50
Sulphur	. 54
Total	100. 54
Calories	6, 130
British thermal units	11, 030

CASSIA COUNTY

In Cassia County the Goose Creek coal-bearing district has an area of 156 square miles. Here lignite occurs in beds in sediments which are presumably of Eocene age and which greatly resemble the Payette formation. The lignite, which when fresh is black or very dark brown, weathers to flakes and scales, which show the presence of a considerable amount of earthy matter. There are two main lignitic coal beds, the lower of which is the best in quality and ranges from 3 feet to 5 feet in thickness. The upper bed varies from 14 inches to 9 feet in thickness but is very dirty and impure. The material is of no great value as fuel because of its high ash and moisture content. A typical analysis is given below:[94]

---

[93] C. F. Bowen. U. S. Geol. Survey, Bull. 531, p. 245, 1913.

Analysis of lignite coal, Worthington mine, Goose Creek district

	Per cent
Moisture	11. 30
Volatile matter	35. 80
Fixed carbon	28. 50
Ash	24. 40
Sulphur	. 85
Total	100. 85
Calories	4, 370
British thermal units	7, 860

CLEARWATER COUNTY

In the Orofino field around Orofino in Clearwater County, and extending into Lewis and Idaho Counties, coal ranging from lignite to subbituminous occurs in beds 3 feet or less in thickness between beds of clay and sandstone which are interstratified with the Columbia River basalt flows. The coal is jet-black and is mostly dull, but has a few bright layers. Woody structure is evident in parts of the coal and as a whole it is laminated, showing thin plates ranging from films to bands 3 mm. in thickness. The fracture is irregular and the jointing somewhat columnar. Considerable resin in globules as much as 8 mm. in diameter occurs along the bedding planes of the coal. The coal is hard and when pulverized gives a black powder with a brownish tint.[95]

FREMONT COUNTY

In Fremont County the Horseshoe Creek coal bearing district is a division of the Teton Basin coal field. The Horseshoe Creek district is 25 miles southeast of St. Anthony and 10 miles southwest of Haden station on the Oregon Short Line Railroad. The district covers 6 square miles, only a part of which is underlain by coal beds which are thick enough to be workable. The beds of coal are not continuous and vary greatly in thickness. The thickest bed exposed is at the Horseshoe mine. Here the coal is 11 feet thick, but it includes a 10-inch bed of sandstone and almost 2 feet of bony coal. At the Brown Bear mine the coal averages 5 feet in thickness, but includes some small shale partings. The coal-bearing strata dip steeply and the area is much faulted. The coal is black and hard but it is badly shattered and broken by faulting in the area. Much of the coal comes out fine and even the larger lumps are so shattered that they will not stand handling. The coal is bituminous and rather pure but is noncoking. A typical analysis of an air-dried sample is as follows: [96]

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[94] C. F. Bowen. U. S. Geol. Survey, Bull. 531, p. 252, 1913.

[95] C. T. Lupton. U. S. Geol. Survey, Bull. 621, p. 99, 1915.

Analysis of coal, Horseshoe mine, Horseshoe district

	Per cent
Moisture	3. 6
Volatile matter	41. 5
Fixed carbon	52. 6
Ash	2. 3
Sulphur	. 4
Total	100. 4
Calories	7, 475
British thermal units	13, 460

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[96] E. G. Woodruff. U. S. Geol. Survey, Bull. 541, pp. 379–339, 1914.

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